112. Sediment with fine ophite above
below Conglomerate 8. (227) feet
114. Epidotic sandstone, Conglomerate 7?
below Conglomerate 8 (267) feet
117. ?
120-125. Feldspathic melaphyres; and amygdaloids with copper.
126. Conglomerate 6 ?
below Conglomerate 8 (815) feet
129. Conglomerate fault repetition of above ? or 5?
below Conglomerate 8. (955) feet
132. Fine grained ophite
134. Scoriaceous conglomerate
below Conglomerate 5. (395) feet
136, 139, 141, 142, 144 all are ophites with scoriaceous tops
146. end of section
below Conglomerate 5 (945)
below Conglomerate 8 (1900) feet.
below Conglomerate 9 (4915) feet
below Conglomerate 15 the Allouez (7740) feet
Total column 760+7740=8500

These drillings were examined by Mr. R. C. Pryor, E. M., the engineer at the time, and a record made and a cross-section constructed. I was also permitted to examine both the cores and Mr. Pryor's notes on the same, through the kindness of Mr. A. C. Burrage, which gentlemen with Mr. R. H. Shields, the Agent, and Mr. Edward Shields I am glad to thank for favors and assistance.

Mr. Pryor, of course, examined them with particular regard to the different amygdaloids and the occurrence of copper. I naturally supplemented his work by paying more especial attention to the different belts of trap, their petrographic character and grain, and have tried to separate the column into the different lava flows. As, however, it is not possible to determine in the boxes which have been rehandled the exact depth at which a given drill core came I have often used Pryor's figures in cases in which I was sure that we were referring to practically the same belt. Otherwise there may be two or three feet difference, probably sometimes to be accounted for by the fact that the bottom of the flow is often slightly amygdaloidal for two or three feet or more. In such cases Pryor would naturally take the top of the amygdaloid two or three feet higher than the top of the flow so that by taking his figures in such case I make an error of a couple of feet perhaps. However, when we consider possible errors in the course of the drill hole, and the dip of the lodes, this becomes an inappreciable error. I do not repeat here all Pryor's notes on the amygdaloids, or the occurrence of copper.

In the first place I give the name of the flow, the interval for each drill hole that I assign to the flow, usually consisting of a certain amount of amygdaloid and a certain amount of trap, preceded by Arc. and the number of the drill hole, thus, Arc. 5, 1-8. Next follows in parenthesis the thickness of the flow as computed and often the total distance from certain planes of references, the base of Conglomerate 15, the Allouez or Albany and Boston being the most important one. Next follows further notes, comparisons and descriptions.

The drill holes run in order, taken from northwest to southeast as follows: 5, 6, 8, 7, 1, 2, 19, 20, 21, 22, 4, 3, 9, 10, 11, 12, 13, 14, 15, 16.

No. 5 was started about 900 feet horizontally across the formation from the foot of the St. Mary's epidote lode. (950 feet on a line making with the Albany and Boston conglomerate's strike an angle of 87° 20′.) It is only 1,000 feet from Marvine XV.[1] There was 8 feet of stand pipe to bed rock.

1. Melaphyre porphyrite.
Arc. 5, 8-40 (32)
Light gray porphyritic feldspar, dark green dots of delessite 1 to 2 mm., brown matrix. This is probably not the typical olivinitic augite porphyrite with idiomorphic augite, like the ashbeds proper, but the intermediate type like Marvine's Eagle River Section bed No. 87. This is of the same type as the 226 feet of melaphyre reported by Marvine 740 feet above the top of the Albany and Boston Conglomerate 15, on the St. Mary's property Section XV.
Base above the Albany and Boston Conglomerate 15, about[2] (760)
2. Melaphyre porphyrite.
Arc. 5, 40-48 (8) ? (8)
With two feet of dense massive epidotic amygdaloid at top, base uncertain. Cf. Marvine's 4 amygdaloid 14 melaphyre.
3. Melaphyre porphyrite.
Arc. 5, 48-52 Amygdaloid (40)
52 to 89 trap
Conspicuously glomeroporphyritic, with occasional larger phenocrysts.
4. Melaphyre porphyrite.
Arc. 5, 89-93 Amygdaloid
93-132 trap (42)
Base above the Albany and Boston conglomerate probably more than (670)

Amygdaloid of calcite chlorite and epidote extending down below the fine grained amygdaloid at the top.

[1]References to Marvine or to his section in Vol. I of the Reports of the Michigan Geological Survey, Part II, Chapter V.
[2]At an angle of 50°,—more if the dip angle is steeper; at 52° 3/4 791.

5. Melaphyre glomeroporphyrite, several flows?
   Arc. 5, 132-178 (46)
   Amygdaloid at the beginning and at 144, 153, and 161 feet. Rarely there are large feldspar phenocrysts, but the flow is generally glomeroporphyritic, at 172 is a light green streak. Calcite, laumontite and epidote occur in the amygdaloid.
6. Melaphyre glomeroporphyrite.
   Arc. 5, 178-190 (12)
7. Melaphyre glomeroporphyrite, two flows? or slip.
   Arc. 5, 190-200 amygdaloid
   200-260 trap (60-)
   Finer grained at 215 to 227, and veined at 232 feet. Glomeroporphyrite, with larger phenocrysts of feldspar also. Arc. 5, 232-242 is like the trap of the Franklin dump and the beds at the top of the drill hole VI Isle Royale, which are supposed to be between 300 and 400 feet above No. 15. Cf. Tamarack 5b 33=T 4b .27 and the glomeroporphyrites beneath it down to T 5b 48. At Arc. 5, 215-227 it appears finer; at 232 much veined.
8. Melaphyre porphyrite.
   Arc. 5, 166-280 amygdaloid (14)
   Coarse feldspathic about 272.
9. Melaphyre porphyrite.
   Arc. 5, 280-300 amygdaloid
   300-320 trap (40)
   Above the base of the Albany and Boston Conglomerate 15 about (530)

10. Melaphyre glomeroporphyrite.
   Arc. 5, 320 to 324 Amygdaloid (21?)
   -324-341
   Arc. 6, between 35 and 57
   This is not a very well marked bed and may be merely a gush of the large lower flow beneath it. Cf. the beds 11 (cupriferous bed) feet thick 25 and 9 feet thick of Marvine's XV, which in Denton's section at the Peninsula are 15.8, 3.9 and 19.7 feet respectively, their top being 512 feet, respectively 378.9 feet above the Albany and Boston. The boundaries of the beds above are also very uncertain and agree neither in this section, nor in the Peninsula (Franklin Junior) nor the old St. Mary's. I give them comparatively, giving from the lower beds up, from left to right.

Arcadian, Lane	21?	40+14	60?	12 46	42	40	8 32
Arcadian, Pryor,	12+	12T 20A 19T	46A 27T 10A	40T 18A	37T 4A	37T 4A	6T 32
St. Mary, Marvine	25M, 9A	78M	10A 42M 6A	65T 4A	11T 4A	14T 4A	226
Peninsula, Denton	3, 9, 19,7	71, 2	74A 46.8T 4.3	57.2 1.8	32T 4.3	4.9 43	18, 51.8, 21.5

Though we cannot satisfactorily correlate the individual lava flows, we can correlate the group as a whole, none of them very thick, all feldspathic, not ophitic, glomeroporphyritic and probably with irregular streaks of amygdaloid in them. Marvine's XV shows that they occur beneath a heavy bed of coarse grained melaphyre, which corresponds to sheet 20 of Tamarack 5. 1452 to 1834 or to sheet 21, Tamarack 5

1834 to 2011, and that we then have a set of smaller but similar flows (Tamarack 22 and 26) the boundaries of which are hard to determine.

11. Melaphyre glomeroporphyritic ophite, Quincy foot.
   Arc. 5, 341 to 350 Amygdaloid -472 Trap (130)
   Arc. 6 57 and less -152 T=(100+)
   This correlation of 472 and 152 which is reasonably certain seems to imply a dip of 58° (or a fault or a different strike) instead of 50° as taken in the section. Marvine's gives and uses 52°¾ for St. Mary's. The difference in reduction factor is that for 50° it would be .996; for 52°¾, 991; for 58° .974, not over 2% in reducing the thicknesses on the drill holes, but in comparing with horizontal thickness the factors would be .766, .796 and .848 respectively, or very considerable. Thus the distance of the base of this flow above the Albany and Boston conglomerate base may be scaled all the way from 410 to 330, with a presumption that at an angle of 52°¾ it is not far from 370 or in accord with the above figures above the Albany + Boston conglomerate (379)

   I take it that this includes the 32-feet melaphyre, 81-feet melaphyre and 11-feet amygdaloid,—"Supposed Pewabic cupriferous bed"—of Marvine's cross-section XV (124) feet thick, the base of which Marvine makes above the Albany and Boston (354) ft.

   In the 70 fathom cross-cut of the Pewabic it was (318) feet
   This thick glomeroporphyrite has as usual in such flows an accumulation of augite and faint ophitic texture low down, e. g., Arc. 5, 412 and Arc. 6, 131, 145. The base, which is the Old Pewabic amygdaloid, may be marked by a little sediment. There are about four flows between it and the Albany and Boston.
12. Melaphyre, glomeroporphyritic ophite, Old Pewabic and its foot.
   Arc. 5, 472-490 Amygdaloid
   Arc. 6, 152-168 Amygdaloid, T. -256, 104 or (101)
   There is possibly a little sediment at 152 feet. There are occasional larger porphyritic feldspar crystals. Cf. sheet 27 of Tam. 5, and T. 4b 41, and the Franklin dump. There is an epidote vein crossing it at 160-168 carrying quartz and *copper* and probably this is responsible for some discrepancy in description. For instance, while in Marvine's Section XV from the Pewabic Mining Company 1865, we have (29 feet amygdaloid, 69 melaphyre) 98 feet thick, in the Quincy adit we have a belt from 1491 to 1620 (129) feet thick with some 47 feet of amygdaloid and slips and a vein dipping 47° to N. W. above.
   In Marvine's St. Mary's section XV we may assign 9, 10, and 12 feet amygdaloid and 90 feet of melaphyre to this belt (121) which agrees with the Quincy rather than this section. Bottom above the base of Conglomerate 15. 278

13. Ophite.
   Arc. 5, 256-285 (29)
   It is epidotic and fine grained to 261, then ophitic, mottles of 1 to 2 mm. to 278, at the base a fine grained black trap.
   In Marvine's XV we may assign 6 feet amygdaloid and 29 melaphyre to this bed (35 feet). According to his text this is just above the "Albany and Boston Amygdaloid," but according to the Atlas it is just be-

low. Marvine says the bed above marks the lower limit of the coarse grained crystalline melaphyres (p. 85).
Cf. T 3 b 41.
Above the base of the Albany and Boston (249)

14. Feldspathic ophite. (70)
Arc. 6, 285-306+
Base above the base of the Albany and Boston say (105) feet
Here the Arcadian section fails a short distance. We may complete it from Marvine. To this bed we may assign
7 feet amygdaloid "Albany and Boston"
31 feet melaphyre
20 feet melaphyre
58
But from Pryor's section there is not less than 120 feet to the epidote on St. Mary's lode, and with the steeper dips than 50° it would be more. The Pewabic cross-cut XV d gives 16 "green Amygdaloid" + 80+8 Albany and Boston + 41=145 for Belts 13 and 14.

15. Feldspathic ophite probably (65)
To this bed we assign 10 Amygdaloid + (17+38) Melaphyre in XV, 8+41 in XV d

16 St. Mary's Epidote lode. Indurated epidotized Ash. "Jasper" or sandstone.
By Pryor's section 14 feet (5)
By Denton's section of the Peninsula (Franklin Junior) there is 15.8 amygdaloid, + 3.9 trap + 3.9 indurated sandstone. Probably the same as T. 1, 460. In Marvine's XV (probably overlooked in XVa) described as of brown and green compact matrix with amygdules of calcite, delessite, green earth and quartz often very siliceous with some copper. In XVd included in 23 feet amygdaloid correlated with the "epidote" amygdaloid.
In XVe presumably in a 6-foot amygdaloid "light green and brown with hard conchoidal fracture, very siliceous" below a 72-foot bed of trap. Base above the base of the Albany and Boston about (90)

Hubbard says that this belt is in the Peninsula 110 feet west (67.7) feet above, the Albany and Boston, (29.1) feet thick or (96.8) feet.
In the Quincy mine map it is called the Mesnard epidote and is only 60 feet horizontally from the conglomerate. In the adit it did not appear at all, was perhaps also wiped out by the slide.
Cf. Isle Royale VI 81-91

END OF ASHBED GROUP. BEGINNING OF CENTRAL GROUP.

17. Small ophite ? about (10)
In Marvine's XV, overlooked; in XVa, the amygdaloid melaphyre and covered gap directly beneath the "epidote lode."

18. Small ophite ? all that is left of the greenstone.
Cf. in Marvine's XV the 40 feet of melaphyre just above the Albany and Boston conglomerate.
Thickness about (42)

19. Albany and Boston or Allouez conglomerate, No. 15
By Pryor's section (38)

At the Franklin Junior or Peninsula (Denton and Hubbard) (23.6+5.5 fluccan=29.1)
In the Pewabic mine (32)
In the Quincy adits its place is taken by a slide.

The base of this conglomerate is a great reference plane. The strike Pryor found to vary 2° 40′ from that of the Arcadian lode. Some 950 feet horizontally below the Albany and Boston is not shown in the Arcadian section,[1] but may be filled in by the section at the (Peninsula) Franklin Junior mine (Fig. 40) (or one of the Quincy adits which is, however, farther away and quite different), and by the old St. Mary's section given by Marvine.

20. Melaphyre, feldspathic ophite.

Franklin Junior	Amygdaloid	(31) in XV	(40)	
	ophite	(50) in XV	(63)	(81)
		(81)	103	

21. Ophite, feldspathic?

Franklin Junior	Amygdaloid	(13) in XV	(9)	
	ophite	(16) in XV	(31)	(29)
		29	40	

22. Ophite
Amygdaloid (13) in XV; (8) "Ragged Amygdaloid" of XVa
Ophite (30) (15+) "dark green speckled with red, hard"
Altered epidotic seam (14)
Ophite (83) (at 27 feet from foot 2 to 4 in. calcite vein). (140)

23. Ophite. (41)
Amygdaloid (5)
Ophite? (36)

24. Ophite
Amygdaloid 5
Ophite 46 51
Below the base of the Albany and Boston in the Franklin Junior. 342

25. Houghton conglomerate No. 14
Franklin Junior 5.456-524 (51)
Quincy 958-978? (15)
In the Franklin Junior this was divided into three parts,—above 38.5 feet of porphyry conglomerate, then a foot of sandstone, dip 49.5°, then some 28 feet of basic conglomerate. Whereas in the Quincy adit the bed supposed to correspond has on top 2 feet of clay, perhaps a fluccan, dipping about 57°, then about 18 feet of felsite conglomerate dipping 59° to 60°. This change in four or five miles is worth noting for around Calumet, the Houghton conglomerate is supposed to be entirely absent. Are not slide faults responsible for confusion? Base below the base of the Albany and Boston (Cf. 15) at Franklin Junior (393) or according to Hubbard (389)

[1] But note what is reported from Shields above.

Slide (at 1583) at Quincy? (475)
Marvine's XIV and XVb 400 feet horizontally or (380)

26. Ophite, amygdaloid represented by some of the scoriaceous stuff above?
Trap 60 (60)

27. Ophite
Amygdaloid, brecciated with calcite and epidote (12)
Trap (73) (85)

28. Ophite
Amygdaloid (4)
Amygdaloid melaphyre (9)
Amygdaloid (13)
Ophite (41)
one bed? (67)

In the Franklin Junior a steep slide striking northeast and southwest and dipping southeast might involve faulting.

29. Ophite
Amygdaloid (32)
Ophite (58) (90)

30. Ophite
Amygdaloid (32)
Trap (60) (92)

31. Ophite
Brecciated amygdaloid (7)
Trap (30) (37)

Below the base of the Conglomerate 15 (820)

Somewhere near here, depending on the exact dip, Arc. 8, which is about 970 feet horizontally from the Albany and Boston, begins its record.

32. Ophite
Amygdaloid (21)
Trap (5) (26)
(26)

33. Ophite
Amygdaloid (16)
Ophite (5) (21)

34. Basic conglomerate?

Above and below the amygdaloids are so heavy that for some 71 feet amygdaloids are dominant, and this heavy band of amygdaloids is about 186 feet above the conglomerate supposed to be the Calumet. Cf. Tamarack 5, flow 46.

35. Ophite
Amygdaloid with possibly a thin layer of basic conglomerate (20)
Trap (66) (86)

Arc. 8, 68-133
7, 27-50

36. Ophite
Amygdaloid 4
Ophite 48

Coarse altered *cupriferous* seam 2
Ophite 15 (69)

Arc. 8, 133-261?, 128
Arc. 7, 50-210, 160

37. Ophite
Amygdaloid 5
Ophite 42 (47)

Arc. 8, 261-310+1
Arc. 7, 212-222+

38. Conglomerate (No. 13)

Capped by 4 inches of fluccan, brecciated and seamed with calcite from about 14 feet in Franklin Junior, largely of sandstone changing in five feet to a more basic and scoriaceous character, terminating in a six inch seam of sandstone. This resembles the bed in Arc. 8, 290-406. (36)

Under this, at the Franklin Junior were:

33. Porphyrite, feldspathic melaphyre (92)
34. Porphyrite, amygdaloid, with clay cavities[1] (42)
35. Ophite[2] (113 to 123 at Calumet, 103 at the Centennial) seam dipping 56° to the west with seams dipping 45° to east and southeast (103)
36. Ophite (57)
37. Ophite[3] (19)
38. Ophite[4] (138)

113 to 123 at Calumet, 103 at the Centennial.

Thickness from base of Calumet to top of Osceola at the Franklin Junior (451)

Total thickness below Conglomerate 15 (1105)
Hubbard, p. 140, gives (1108)
Below Conglomerate 14 (719)

Then Ophite (15) + (83)=89 in the Franklin Junior cross-cut, 135 in the shaft at Calumet

=Arc. 8, 406 to 491 85
=Arc. 7, 319-395 76

Ophite (5) + (59) =(64), (seamed) in the Franklin Junior cross-cut ? at Calumet, 112.7

= 55 or more in the shaft
= Arc. 8, 491-637
= Arc. 7, 395-523

Ophite (4) + (121) =(125)
= Arc. 8, 637+
= Arc. 7, 523+

Ophite (8) + (84) =(92)

To Kearsarge or North 364
Star cg. 12-10 45 Capped by 16 inches of fluccan
409

[1] 109 to 99 at Calumet, 115 at the Centennial.
[2] These three next flows appear quite different at Calumet (see notes on Centennial cross-cut)
[3] Calumet amygdaloid near here.
[4] Hanging of Osceola?

According to the above correlations, Holes 7 and 8 reach the bed above the Kearsarge conglomerate,—according to Pryor's section, there is about 227 feet between the base of Hole 7 and the top of the Kearsarge North Star, and the whole belt from the Calumet to the Osceola is represented by the disturbed belt from Arc. 8, 310-406 and Arc. 7, 222-319.

The 970 feet horizontally below the Albany and Boston is equivalent to from (735 at 48° to) (762 at $52\frac{3}{4}$° or) (830 at 59°) and the 1608 feet to the base of the Calumet and Hecla bring it at from (383) to (336) or (278 feet) respectively in Arc. 8.

From the conglomerate Pryor crossed in his run, it is 2470 feet, (Cf. 2581 feet at the Franklin Junior) which will be from 1750 to 1950 or 2100 feet of thickness according to the dip chosen. It is practically the same, allowing for a greater dip, as at the Franklin Junior two miles away (1971).

According to the figures here given it is:

From base of Albany and Boston to base of Calumet and Hecla,	(1108) ft.
From base of Calumet and Hecla to base of Kearsarge,	(842)
Total	1950

Arcadian Holes 8 and 7, though planned to show different strata, appear to show nearly a repetition. Cf.

Arc. 7	222	319	395	520 with
Arc. 8	290	406	491	637
	68	87	104	117

Pryor however thinks the correlation should be Arc. 7.50-212 with Arc. 8.491-637, which is possible as they are both well developed ophites about 150 feet thick. The disturbed belt would then not be the same horizon, but merely similarly disturbed as according to the section Arc. 7.0 should correspond to Arc. 8.420. This would imply a fault of some 300 feet and more, or horizontally 400 feet, as the direction of the holes is nearly at right angles to the strike. I will give the correlation both ways.

They begin in the base (probably of an ophite) a fine grained black trap which may be separated by a little sediment from the next seam. Ophite.

Arc. 8, 133-145 Amygdaloid -261, 128
Arc. 7, 50-60 -212, 162
Amygdaloid top Arc. 8, 261-272-290? 29
Arc. 7, 212-222+ 10

38. Scoriaceous conglomerate and sandstone, the Calumet conglomerate? much disturbed and probably faulted.
Arc. 8, 290?-406, plainly a sandstone about 358, 116
Arc. 7, 212 -319, (cf. 255?), 97?

39. Ophite, amygdaloid top mixed in belt above, mottles up to 3 mm.
Arc. 8, 406-491, 85
Arc. 7, 319-395, 76 or
Arc. 7, 50

At the Franklin Junior the beds under the "Calumet conglomerate" are reported as a porphyrite which does not appear here, except possibly in the disturbed belt?

40. Ophite, about 10 feet of amygdaloid, mottles up to 4 or 5 mm.
Arc. 8, 491-637, 146
Arc. 7, 395-523, 128 or
Arc. 7, 50-212, 162
Below base of Calumet and Hecla No. 13. (50+?) (231)

41. Disturbed belt in part sedimentary.

42. Arc. 7, 212-319, 102 (100)

43. At 212 some amygdaloid, to 222 fine grained green epidotic, then some scoriaceous amygdaloid, dense fragments of amygdaloid, and calcite, red shale? a sediment or slip to 288. 288-319 sludgy. This may include the horizon of the Calumet Amygdaloid.
Base below the Calumet and Hecla? (333)

44. Ophite (top disturbed, in sludge and possibly the horizon of the Osceola amygdaloid.
Arc. 7, 319-395, 76 (74)
at 319, 334, 351 feet
Mottles 1-2, 2, $2\frac{1}{2}$ mm.
407

45. Ophite. (Probably the fourth above the Kearsarge conglomerate top, probably the *Osceola amygdaloid*?)
Amygdaloid Arc. 7, 394-401, 7 feet top to
Trap 523 (125)
Well-marked; at 437, 452, 463, 489, 499, 502, 512 mm.
Mottles 2, 3, 5, 3, 3, 1 to 2, 1 to 2 mm.
Cf. (83) or (138) feet of Franklin Junior
Base below Calumet and Hecla 50+? (532)
Above the base of the Kearsarge conglomerate by scaling > (310)
Cf. with 863 feet at the Franklin Junior (842)

46. Ophite? 64?
Amygdaloid Arc. 7, 523-530
Trap -544+ 21+ (64) or (83) feet at Franklin Junior?
Base below the Calumet and Hecla (596)
The three beds above are some of the large ophite flows which occur in the Franklin Junior cross-cut just above the Kearsarge and below the supposed Osceola?

47 &
48. Two ophites not pierced in this cross section.
Cf. the 92 feet of ophite flow just above the Kearsarge conglomerate at the Franklin mine, and the 125 feet just above (125)
(92)
(813)

Above correlations are such as would be suggested by Pryor.

49. Kearsarge conglomerate say to balance (29)
At the Franklin Junior it is (36) (842)
Upon comparison with the Calumet and Hecla section it is clear that between this and the Arcadian-Franklin Junior sections a thinning of 100 feet or so has taken place. This does not appear to be due mainly to the thinning of the various beds, but rather to the elision of some of them by slide faults confined mainly to the upper part of the section, which may be represented by the disturbed belts in Holes 7 and 8.

The first 400 feet above the Kearsarge conglomerate, composed in the Franklin Junior of four heavy ophite flows, or even the first 500 do not show much disturbance there or at Calumet, but the first 300 feet under the Calumet conglomerate show much disturbance which evidently corresponds to the disturbed belt (or, if they are not the same, belts) of Arc. 7 and 8. This disturbed belt at Calumet centers about and above the Calumet amygdaloid, the top of a large ophite flow just above the Osceola. I have correlated accordingly.

The following beds are taken from Pryor's section, and were compiled by him from records at Calumet.

49. Kearsarge conglomerate (46) feet dip on Pryor's profile 59°¼
50. Trap (58½) feet
51. Amygdaloid (12) and Trap (124), (136) feet
52. Amygdaloid (31) and Trap (31), (62)
53. Amygdaloid (15) and Trap (33), (48)

In Arc. 1[1] there is a fissured melaphyre at Arc. 1, .39 feet

54. Amygdaloid (25) and Trap (78), (103) feet. Total from base of Kearsarge conglomerate (407) feet. The amygdaloid under this, Pryor takes to be the first belt encountered in No. 1 hole 53-57 feet. This was put down at an angle of 45°, i. e., so nearly at right angles to the dip which is probably about 58° that the reduction factor (= sin 103°+) is .974.

55. Amygdaloid (4) and Trap (56) feet, Pryor. I make the lower contact at Arc. 1, 109 feet. The belt is slightly glomeroporphyritic at the top, ophitic at Arc. 1, 79 feet.

56. Amygdaloid (7) and Trap (19) Epidote seam (3) Trap (4). 30 feet of a small flow, epidotic from Arc. 1, 135 to 138 and then amygdaloid again.

Amygdaloid (23) and Trap (26), in all Pryor (82)

Very feldspathic and but faintly ophitic, coarsest near 167.

Cf. C. & H. C 56 to 84 (28+) which is also feldspathic ophitic.

Total from top of hole 191

Total from base of Kearsarge conglomerate (549)

57. Amygdaloid melaphyre Arc. 1, 191 to 211 (20)

seamed at an angle of 26° to the hole

58. Amygdaloidal melaphyre or two or three flows Arc. 1, 211 to 224 (13)

A hard gray amygdaloid, seamed at 219 and 222 feet.

59. Amygdaloidal melaphyre. Amygdaloidal 224 to 239, to Arc. 1, 240 (16)
60. Amygdaloidal melaphyre Arc. 1, 240 to Arc. 1, 255 (15)

Pryor Amygdaloid (6) with Trap (10)

61. Amygdaloidal melaphyre, Arc. 1, 255 to 262 (7)

Cf. Calumet and Hecla C. 84 to 135 (51) feet, which has three or more flows.

The above five flows 57 to 61 are not clearly defined and may be more or less gushes of one, together they make a broad amygdaloidal belt, the thickness of which is about (71) feet, and the base below the top of Hole 1 (262) and so below the base of the Kearsarge conglomerate (605) feet.

62. Ophite. Arc. 1, 262 to 385. 123 feet or reducing. (121)

Cf. C. and H. C 135 to 226 (91) feet; and Central mine, (Figure 33, Belt 53, d. 2.259-333 (74).

This begins with 9 feet of marked amygdaloid and at Arc. 1, 278 to 290 is another marked amygdaloid, which may, however, be a flowage seam.

[1] In Figure 42, drill hole 1 is shown, just N. W. of drill hole 2, but its number has accidentally been omitted by the draftsman.

At 1, 299 feet it is for 2 feet epidotic to 302 feet, and at 312 to 317 feet and 320 to 324 feet and at 347 feet about 8 feet and at 304 to 311 it is amygdaloid in spots, but the coarsening grain shows it is all one flow and that these are merely flowage or alteration streaks. At 340 feet the mottles are about 10 mm. across? This is taken to be the hanging trap of the Kearsarge amygdaloid and its base is then below the conglomerate[1] (726) feet.

63. Kearsarge Trap,—an ophite characterized by the presence of porphyritic, sharp, flattened crystals or groups of crystals of labradorite up to 20 mm. long especially in its upper part which is otherwise either amygdaloid with red amygdules and white centers or a dense, fine grained, hard trap, while the bottom is plainly ophitic, though often dense, hard, and aphanitic for an unusually large distance from the bottom.

In Arc. 1, 385 feet to the end at 428 feet which is like Arc. 2, 78 from which to the base at Arc. 2, 143 feet is 65 feet or in all (109) feet

Arc. 2, 42 to 50 is a laumontite amygdaloid which then changes to a yellow-green, hard white trap which at 2, 81 is rather feldspathic, independent of the coarse labradorite crystals, but at 94 to 96 shows the 3 to 4 mm. ophitic mottling plainly.

Hole 2 shows there must be not less than (143-42) 101 of the Kearsarge footwall trap and its amygdaloidal top shows that there is not very much more. If the dip is steeper than 58 to 59° there will be more. Cf. C. & H. A. 54-198 (144) and C. & H. C. 226-281+ (55+)

Cf. Central mine 2, 333 to 408 (75) which is somewhat different in appearance.

At the Wolverine mine the foot trap is 187 feet, it is said.

64. Wolverine sandstone. Marvine's slaty sandstone No. 9, Arc. 2, 143 to 178 (35)

The first 21 feet are red, sandy shale dipping (8:15 or) 72° apparently. Dip on profile 59°. Its top is by addition (846) or by scaling (831) feet below the Kearsarge conglomerate and its base below the base of that (866)

Marvine makes No. 9, the "slaty sandstone" (720) feet below the Kearsarge at the Shelden and Columbia, but he also recognizes 10 and 11 as different beds. From 12 to 10 and 11 is (655)+(196) feet. The Wolverine sandstone is about 21 feet thick, and may correspond only to the upper 21 feet of this.

65. Ophite. Arc. 2, 178 to 262=84 or (82)

Unless the scoriaceous base of the Wolverine sandstone be such in part, there is no marked amygdaloid top to this. At Arc. 2, 187 it has a 2 mm. ophite mottling. At 220 this is about 4 mm. At Arc. 2, 262 it becomes fine grained, though there is no clear contact.

This is Pryor's amygdaloid from 228-235 and trap to 260, "much altered from 243 to 255."

Below the base of the Wolverine sandstone (82) feet

C. & H. A. 198-270 (72) top lost? Wolverine 319-406 (56)

Central mine 2, 412-442 (30) and 2, 442-498+ (56+) which agrees better.

66. Melaphyre.

Feldspathic verging on glomeroporphyritic.

Arc. 2, 262 to 315 (51)

[1] Scaling from Pryor's cross-section from the top of the Kearsarge conglomerate, with an assumed dip angle of 59°.

Cf. C. & H. A. 270 to 361 (91); Central mine 442 to 498+ (56+) which really agrees better with the bed above; also Central mine) 0 to 27.

This includes Pryor's amygdaloid 260-273, "good looking, chocolate medium,—a little epidote in places,—315 trap grayish, medium, in some spots altered."

67. Scoriaceous conglomerate? at Arc. 2, 315 to 320? (5)?
Cf. Central mine 1, 27 and 43 passim also.

68. Melaphyre, a feldspathic bed with a scoriaceous amygdaloid top passing into conglomerate (Arc. 2, 315 to 322) 464.

At 377 and other points coarse doleritic spots, labradorite 8 mm., and red, micaceous, altered olivine show well, also dark chloritic amygdules. Toward the bottom it is faintly ophitic. Finer? at Arc. 2, 436 with a green amygdaloid streak at 452, but apparently coarse and all the same flow to the end of Hole 2 at 464. This is probably Dr. Hubbard's "*inclusion*" bed and the spots and streaks are the inclusions.

This includes Pryor's amygdaloid 2, 315-329, part chocolate, part dark, pretty well sprinkled with calcite, some laumontite, 315-320 looks like amygdaloid conglomerate,—464. Trap medium altered, in spots and seams, sometimes a little bunch of epidote, at 447-450 a little bunch of *copper* and epidote. End of trap, at bottom finer than at top. I put the mottling 10 mm. at 440 with some questions. This coarseness of grain would indicate about 150 feet more. This would correspond at a dip of 59.5° with Arc. 19, 155 feet instead of 120, i. e., 35 feet difference, and would make the bed 267 feet thick instead of 217. It is epidotic at 129 and the contact may be a few feet higher up. However, we correlate Arc. 2, 315 to 464+ and Arc. 19, 43 to (120) or 139 (217)

Pryor makes No. 19, 0-43 overburden, then to 120 trap. At 63 to 67 calcite fissure gray, becoming darker toward the end. The Pryor section makes the dip of Hole 19 52°¾, but that appears to be too flat by correlations. C. & H. A. 361-406 is a group of amygdaloid and trap belts with sediment and scoria. Cf. Arc. 1, 315 to 322. If we can thus group them then to this belt will correspond C. & H. A. 361-656 (295) which like this is feldspathic only faintly ophitic, if at all, but doleritic. Central mine Hole 1 shows also a series of ophites with marked scoriaceous amygdaloids at this horizon.

69. Scoriaceous conglomerate? Arc. 19, 139-139 1

Below the base of the Wolverine sandstone about (355)
Cf. C. & H. A. 656; Franklin Junior d. 3, 535.

70. Melaphyre.

From Arc. 19, 120 to 135 it is markedly amygdaloidal. One foot epidotic at 153. There are signs of scoriaceous conglomerates along here possibly misplaced.

Arc. 19, 139 to 153, 33 or (32)

71. Ophite with scoriaceous amygdaloid and basic sand or sludge.
Arc. 19, 153 to 251, 98 or (95)
The above two may be one belt. Cf. C. & H. A. (656 to 752.6+)

Pryor comments "42 feet amygdaloid, reddish, rather rotten with calcite, prehnite and sludge."

72. Ophite.

It is poorly amygdaloid to 288 feet, then ophitic mottles which are coarsest,—6 mm. across at about 345 feet, at 350 feet 5 mm., plainly finer at 376 feet.

Arc. 19, 251 to 270 amygdaloid (with scoriaceous conglomerate?) to 398 trap 147 or (143+)

Below the base of the Wolverine sandstone (625)

73. Fault zone possibly bed of sediment, a mixture of sediment, clay fluccan and fine grained trap to be divided in uncertain amounts between the belts above and below. Pryor also thinks that the core ran through a seam here.
Arc. 19, 398-424 (25)

Below base of Wolverine sandstone (650)

74. Feldspathic ophite, mottling not well marked.

The base has long amygdules and a *little copper*, coarse, with doleritic spots, and prehnitic amygdules; at 475 doleritic spots of very coarse feldspar.

Cf. Franklin Junior d 1. 126-243 (117)
Arc. 19, 424 to 620 (196 or) (190)

Below the base of Wolverine sandstone about (840)

75. Feldspathic ophite.

Coarse amygdaloid with large amygdules. At 705 to 708 4 to 5 mm; at 650 and 719 3 mm.

Arc. 620 to 745, 125 i. e., (122)

Below the Wolverine sandstone (962)
Hole 19 ends at 767½ feet.
We pass here to Arc. Hole 20 of which this is the top bed.

76. Sandstone (No number by Marvine, say 8½.) Cf. "Old Colony" sandstone.

This has on top red shale, then about two feet of *copper bearing* epidotized sandstone, and clasolitic veins of this epidotic sandstone extend down into the red and white amygdaloid beneath. In the Arcadian 20 at 54 feet there is a seam of epidote and indurated sediment underlain with amygdaloid largely ground to sludge, which appears to be the same. The dip using this correlation would be 58.5°, instead of the flatter dip used in the section. So I think we may safely assume a dip of about 59° through Hole 19 as well as for the holes each side.

Arc. 19, 745 to 749½ (4)
20. 54+

Below the Wolverine sandstone (968)

This may be the "Old Colony" sandstone which is 980 feet below the Wolverine.

The 122-foot bed in Arc. 19, just above, is too thick to be anything but the top bed of Arc. 20, and beneath it in each case is similar epidotic and indurated sediment, though Arc. 20 seems to be near a fault, and the contact is not clear.

77. Ophite, feldspathic, often doleritic.

Pryor says that this amygdaloid is light gray to chocolate, good average, with some epidote, the top part of the trap also slightly amygdaloid, the bottom brown.

Arc. 20, 54 to 134 80 or (78)

The samples were perhaps not in good order,—indurated sediment and sludge were scattered through.

78. Ophite, feldspathic, doleritic

Dip from amygdaloid contacts seen in the drill core 59° to 64°. From

the cross-section it would only be some 49°, and presumably in projecting on the cross-section the strike was taken too much north; the distance along the strike is considerable relative to that across it.

Arc? 20, 134 to 200, 76 (54)
Arc. 21 to 95, 74

From the base of the Wolverine sandstone (1100)

Above the hanging of the Arcadian lode about (1350)

The feldspathic doleritic ophites of the top of Arc. 20 and 21 and bottom of Arc. 19 are hardly ophites at all,—may be a recognizable group, and if so, are recognizable in Franklin Junior Hole 1, and Hole 2.

79. Ophite

A small flow somewhat amygdaloid throughout. Mottles not over 2 mm.
Arc. 21, 95-124? (29) or (28)
Arc. 20, 200-239 (39)

80. Ophite, feldspathic, with doleritic inclusions in Arc. 20.

The amygdaloid is well marked and has COPPER.
Arc. 21, 124-140 am.,-247 trap, 123 or (120)
Arc. 20, 239-250 am.,-291 trap+

The dip by correlation is about 59°, according to the amygdaloid contacts 59°, 64°, 75°.

Above the hanging of the Arcadian lode about (1202)

81. Brecciated amygdaloid and feldspathic ophite.

Dip between 59° and 75° according to amygdaloid contacts which average along here 65° if the holes are at 45°
Arc. 21, 247-332½, 85½ (83)

82. Brecciated amygdaloidal melaphyre

Arc. 21, 332½-348 15½ (15)

83. Scoriaceous amygdaloid and doleritic ophite

Arc. 21, 348-430 80 or (78)

From base of Wolverine sandstone (1424+)

84. Scoriaceous amygdaloid and feldspathic melaphyre

Arc. 21, 430-471 am.,-550 trap, 120 (116)

From the base of Wolverine sandstone (1540+)

85. Melaphyre.

This is not ophitic, compact and rather fine grained.
Arc. 21, 550-571 am.,-663 trap, 113 or (110)

From the base of the Wolverine sandstone (1650)
Above the Arcadian hanging wall (800)

86. Ophite, dark, yet but faintly ophitic

Arc. 21, 663-667 marked red amygdaloid with some copper trap 756+ (128)

Arc. Hole 22 begins in a massive trap which is not very remarkably ophitic yet dark and chloritic, seamed, with brown specks of altered olivine. It begins somewhat amygdaloidal at the top 17 feet and appears to have 2 mm. mottles at 40. At 91 feet may be the bottom. Assuming 30 feet not represented this would make the bed (104) feet thick, plus some allowance for amygdaloid. Scaling from Pryor's section makes it (120); steeper dip would give greater thicknesses. The last bed in Arc. Hole 4, bored horizontally northwesterly[1] from Arc. 4, 362 to Arc. 4, 453 is fissured, faintly ophitic and doleritic and presumably the same bed.

N. B. From here on the thicknesses are derived from horizontal measurements by multiplying by sin $57\frac{2}{3}$=.845 while previously they have been obtained from thicknesses along drill holes at an angle of 45° by multiplying by sin 76°=(180°-59°-45°)=.970 from No. 9 down.

Base from the base of the Wolverine sandstone about (1778)
Above the Arcadian horizontally 794 feet, or (672)

87. Ophite

Arc. 4. 348-362 is an amygdaloid the samples of which were ground up, the "vein" reported to be about 9 feet thick, there was a laumontite vein above it at 371 to 374 feet.

Arc. 22, 88-95 is called amygdaloid chocolate at top, epidotic at bottom.

At Arc. 22, 160 there is a laumontite seam and it seems finer grained above it, possibly a slip, also at 4, 371 to 374.

The underlying trap is a dark and well-marked ophite, represented by

Arc. 4, 348 to 250, in all 112 or by Pryor 141 feet across, which reducing by .845, gives a thickness of (95) or (119)
Arc. 22, 91-210, 119 or (115)

88. Melaphyre.

Arc. 4, 250-243 was a grey-green amygdaloid.

This is feldspathic only, coarsely amygdaloid, not ophitic; the amygdaloid is reddish decayed, amygdaloid faint .

Not a marked flow.

Arc. 4, 250 or 221-188, 62 or 33 feet across which reducing by .845 gives (52) or (28)
Arc. 22, 210-216 amygdaloid -250 trap. (40)

89. Amygdaloidal ophite.

This is more or less amygdaloid throughout and it may be made of smaller flows, e. g., 4, 173 to 184 amygdaloid with prehnite and copper and 4, 149-158.
Arc. 4, 188 to 121, 67 feet across which reduces to (57)
Arc. 22, 250-254 amygdaloid grayish green -288 (38)

From the base of the Wolverine sandstone say (1982)
Above the Arcadian hanging (468)

90. Arc. 4, 121 to 32, 91 feet across which reduces to (77)
Arc. 22, 288-316 Am-3700 or so (82)
Above the Arcadian hanging (391)

91. Amygdaloid melaphyre

382 feet above the top of the Arcadian lode, 365 by scaling from Pryor's plan to Arc. 22, 370.

Arc. 22, 370-398 is a grayish, coarse amygdaloid.

Arc. 4, 32-11 is a greenish, much altered amygdaloid with considerable laumontite, evidently the top of the trap belt at the end of the cross-cut west from the 8th level, which was 432 feet long, i. e., ends (356) feet

[1] So that the uppermost beds are those struck at the end of the hole. Hole 4 is shown in Figure 42, but its number is omitted.

above the foot of the Arcadian hanging. Comparing the thickness of belts in the horizontal hole and the one at 45° (No. 22) we have $\frac{33}{21}$, $\frac{91}{82}$, $\frac{67}{38}$, $\frac{62 \text{ or } 33}{40}$, $\frac{112 \text{ or } 141}{119}$, values ranging from .90 to .57, averaging .74 or from the total distance about .81 whence by the formula:

(Cot. dip +1) x cos 45°=ratio length along horizontal hole .

Cot dip + 1 = length along hole at 45°

$.70\frac{1}{7} \cdot .57\frac{1}{1} = 1.751$. ∴ dip=53° (or from .74 62°½). Scaling from Arc. 22, 370 and Arc. 432 to the Arcadian lode we get 52°⅓, while Pryor shows the actual dip of the Arcadian No. 2 shaft to be 56°. Hubbard gives the dip of the Arcadian 56.5°.

The correlation of Arc. 22 at 370 and Arc. 4 at 32 feet gives 53°¼. The coefficient of reduction for the thickness of a belt at an angle of 45° is sin 82°=.990 about 1%.

92. According to Marvine (Plate XIX, Section 1, Atlas to Vol. 1) down at least to (300), perhaps down to (180) above the Isle Royale Arcadian lode[1] is a heavy bed of trap, the faintly amygdaloidal and somewhat glomeroporphyritic upper part of which is found in Arc. 4, 1-32? It is not clear that there is any contact here or near the bottom of Hole 22 from the samples, though Pryor thought so. It may be merely a pseudamygdaloid or altered belt, so that the thickness given may perhaps need to be added to the previous belt.

Thickness perhaps (211)
Foot above the Arcadian (180)

93. Shelden-Grand Portage-Columbian amygdaloid and underlying trap. It is a rather coarse amygdaloid? (70)

94. Small amygdaloid and melaphyre (Marvine 11. k) ? (39)

95. " " " " " " (44)

The Isle Royale Hole 3 does not seem to show these beds. Are they faulted out?

96. The immediate hanging of the Arcadian lode is exposed at the mine and is a coarse feldspathic amygdaloid (27)

Hanging of Arcadian lode below Wolverine sandstone (2450) feet

The Arcadian lode dips 56.5° and strikes N. 37° 49′ W.

Between the Arcadian lode and the beginning of drill hole 3, at the end of a cross-cut at 104 feet into the foot, the section is completed by exposures on the surface, practically continuous, which show that the interval is occupied by a melaphyre full of bombs or inclusions as described by Hubbard, pages 77, 78 and 132. Compare also Arc. 21, 144 to 177. Such inclusions in drill holes often make difficulty in determining the exact bounds of different flows.

97. Inclusion bed, melaphyre.
To Arc. 3, 17, 140 feet horizontally or (118)

Below the Wolverine sandstone 2568

98. Amygdaloidal melaphyre.
Greenish amygdaloid, coarsely amygdaloidal throughout.
Arc. 3, 17 to 39, 22 feet horizontally or (19)

[1] See Belts 3 and 1 of the Isle Royale, § 14, just below.

99. Ophite.
Coarsely amygdaloidal, chocolate and not numerous amygdules, but at the foot of the amygdaloid (48′-50′) very epidotic.
Arc. 3, 39 to 143, 104 feet horizontally or (88)
Amygdaloid melaphyre
Arc. 3, 143-160, 17 feet horizontally or (14)

Below the Wolverine sandstone (2689)

100. Melaphyre.
With epidotic brecciated amygdaloid, with chlorite and epidote well-marked, and a fine grained, dark, compact trap below. This is crossed by a vertical seam near 180 feet.
Arc. 3, 160-196, 36 feet horizontally or (30)

101. Ophite.
The amygdaloid contains a trace of *copper*, the trap shows well-marked mottling up to 4 mm! at 225 a seam makes an angle of 47° with the drill hole.
Arc. 3, 196 to 235, 39 feet horizontally or (33)

102. Ophite.
Green and white, epidotic amygdaloid fading off to Arc. 3, 250. Then ophitic; at 294 ⅔ mm. at 304 6 mm.
Arc. 2, 233-320, 87 feet horizontally or (73)

103. Ophite.
Amygdaloidal, (trap 333-340)
At 339 the dip appears to be 56° and at 390 seams of laumontite appear to dip 58°.
Arc. 3, 320-394, 74 feet horizontally or (62)

104. Ophite.
(394-397 amygdaloid, greenish, epidotized,) really includes the next belt which I separated because Pryor did in Arc. 3; in Arc. 9 we both keep them together.
The thickness of this hole in horizontal cross-cut and drill hole indicates 74° dip or so, but the fault may have something to do with it.
Arc. 3, 394-491 57 feet horizontally or (48)
Arc. 9, 14
Below the base of the Wolverine sandstone (2935)

105. Ophite.
451-453 faint green and white amygdaloid; I think this is a bomb, and this flow and the one above the same, because I make the mottling at 472, 5 mm. and 491, 3 mm. and again in Hole 9 Pryor and I agree in making one big belt above the conglomerate.
Arc. 3, 451-508, 57 feet or 49
Or adding this and the belt above as one flow (97)
Arc. 9, 14 (beginning of rock) to 116 (102)
Total from the base of the Wolverine sandstone, Marvine's No. 9, to the foot of the ophite which is the hanging wall, (with a slide) of No. 8, conglomerate 2989
Below the top of the Arcadian lode 549
From foot to foot Hubbard makes 552
SLIDE; clay fluccan, apparently to be counted mainly with the overlying trap of which it is a disintegrated portion.
Arc. 3, 508 to 515, 8 feet horizontally, or 7 feet

END OF CENTRAL, BEGINNING OF BOHEMIAN RANGE GROUP.

106. Porphyry conglomerate. Winona conglomerate. Marvine's No. 8, the first conglomerate with well-marked felsitic pebbles that we have met in descending the section, since the Kearsarge. This is a regular conglomerate with rounded acid pebbles, also much epidote, calcite and basic material. The dip is apparently 63° to 65° in Arc. 3 and in Arc. 9, 52° 10′, ave. about 58°.

The frequency of conglomerates below is marked here and elsewhere.

Arc. 3, 510 to 548 anyway and perhaps to the end of the hole, 32 feet horizontally, or (27)

This also appears in Arc. 9. 480 feet southeast of the Douglas shaft, from Arc. d 9. 116 to between Arc. 9. 133 and 140 feet or (17) to (24) feet thick and without the clay cap.

The distance horizontally from the top of Arcadian to the base of the conglomerate in the cross-cut is 120+548=668

The distance horizontally from the top of Arcadian in Arc. 9 may be computed as 480+135=665+ and the thickness accordingly below the top of the Arcadian (565)

Or below the base of the Wolverine sandstone (3015)

In this computation of the distance between conglomerates (8) and (9) I do not think that the error in dips is likely to be over 3° and the error in thickness from that cause over a very few feet, but there are uncertainties in correlation of certain of the holes which may amount to 50 feet perhaps.

107. Ophite, doleritic.

At 189 feet laumontitic fissures, and coarse doleritic seams at 212, 228, 244 feet.

Reduction factor used hereafter sin 45°+56.5°=sin 78.5°=.98

Arc. 9, 133 to 266, 133 or (130)

108. Melaphyre, amygdaloid, epidotic, and clasolite, then coarse feldspathic and chloritic and epidotic at base.

Arc. 9, 266-293, 27 or (26)

109. Melaphyre, amygdaloidal, gray-green and epidotic.

Arc 9, 293-310, 17 (17)

110. Ophite marked.

This ophite shows the mottling fine and clear down to 1 mm. and this type is absent between Conglomerates 9 and 8 where the feldspathic ophites do not show the mottling plainly and indeed at all only when coarse. The top is brecciated and perhaps a basic conglomerate

Arc. 9, 310-338, 28 (27)

Below the base of the Conglomerate 8 (200)

(Cf. the bed at 267 feet below)

111. Ophite, amygdaloid 335 to 352; ½ mm. mottling at 354. This of the same type as the one above and should be characteristic.

Arc. 9, 338-365, 27 or (26)

112. Seam of sediment, basic sandstone or shale at Arc. 9, 365

Below the base of Conglomerate 8 (227)

Cf. Hubbard p. 134

113. Melaphyre, mainly amygdaloid to 376

Arc. 9, 365-383, 18 (18)

Ophite, fine grained

Arc. 9, 383-395+, 12+ (12)+

Below the base of Conglomerate 8 (257+)

The top of Hole 10 is according to Pryor's section 239 feet below Conglomerate 8. It is said to be 939 feet east of Douglass shaft. The same section makes the distance between drill holes 9 and 10 some 450 feet.

It begins in fine grained, somewhat amygdaloid trap and soon shows some 3 feet of fine grained, yellow, epidotic sandstone from the dip of which on the drill cores we might infer a dip of (45°+22° 50′) 68° or by other observations 61 to 62°, so that there might be a considerable gap between Holes 9 and 10.

114. Epidotic sandstone. The fine grained character and position of this bed is much like that of Conglomerate 7. See Hubbard's remarks in Vol. VI, p. 108 of Pt. II. Cf. also 112.

Apparent dip 61° to 62°

Arc. 10, 40-43, or more

Below the base of Conglomerate 8 (267)-

115. Amygdaloidal melaphyre, exact position of contact uncertain.

Arc. 10, 43? to 53? (10)

Below the base of Conglomerate 8 (277)

116. Amygdaloidal melaphyre, fine grained, with a glomeroporphyritic base.

Arc. 10, 43? to 68, (25) (25)

Below the base of Conglomerate 8 (302)

117. Melaphyre, epidotic amygdaloid for 10 feet,

Arc. 10, 68-141, 73 (71)

Arc. 12, 15-33

Epidotic seam (amygdaloid or sediment?) at Arc. 10. 102-105 and also at Arc. 10, 121 an epidotic sandstone with a little coarse amygdaloid associated. The trap is fine and glomeroporphyritic and there are possibly two or three beds combined here.

118. Melaphyre, coarse feldspathic.

Arc. 10, 141-156 amygdaloid -182 trap, 41 (40)

Below the base of Conglomerate 8 (403)

119. Amygdaloidal melaphyre, amygdaloid about half way, trap rather dark, medium grained in Arc. 12 above 75 coarse feldspathic.

Arc. 10, 182-195 amygdaloid -209 trap, 27 (26)

Arc. 12, 75- 103, 28

Arc. 13, 46- 62, 16

120. Amygdaloidal melaphyre. The trap rather glomeroporphyritic, fine grained.

Arc. 75-82 clasolite amygdaloid

Arc. 10, 209-237?, 28 (27)

Arc. 12, 103-132, 29

Arc. 13, 62-108, 46

Pryor classed all the rest of Hole 10 from 212 down as amygdaloid, but probably it is made up of a series of small flows as indicated, match-

ing the series of flows in the tops of Holes 11 to 13,—the matching of individual flows being very uncertain.

121. Amygdaloidal melaphyre, with a 2-foot epidotic seam
Arc. 10, 237?-262, 25? (25?)
Arc. 11, 19?-42 , 23?+
Arc. 12, 132 -160, 28?
Arc. 13, 108 -120, 12

122. Amygdaloidal melaphyre, cut by a clay seam at Arc. 10, 268 feet.
Epidote and *copper* at Arc. 10, 291 to 297 and from 303 to 313 coarsely amygdaloid, and then doleritic.
Arc. 13, 62-126 64, Coarse amygdaloid but plainly ophitic
Arc. 10, 262-287 am.-324? 62 at 13, 110-115 epidote and quartz amygdaloid (61)
Arc. 12, 33-75 or 90, 41 or 56 Amygdaloid at 12, 41 (56)
Arc. 11, 42- 102, 60 This occurs also with a coarse amygdaloid above, and doleritic below, but I also note occasional large feldspar phenocrystals; *copper* at 108-112 just below (59)

Below the base of Conglomerate 8 (452)

123. Feldspathic melaphyres, much disturbed and with more or less copper; in Arc. 11 coarse and somewhat epidotic to 154; then faintly ophitic and contact at 178 with epidotic amygdaloid; then to 231 numerous calcite seams about at right angles to core, and at 231 a faint amygdaloid.
In Arc. 12, to 82 there is 7 feet of clasolite amygdaloid; then coarsely amygdaloid, between 92 and 103 more plainly so but no plain contacts, fine grained, however, to 117, then redder, and at 132 two feet of epidote, and it remains irregularly amygdaloidal with more copper at 163-165,—possibly another contact. Below this it is coarser and at 206 is doleritic, and faintly ophitic. In Arc. 13, it is coarsely amygdaloid from 140 to 145, fine amygdaloid to 150, then coarser, doleritic at 168, and at 195-8 epidotic, then feldspathic coarsely amygdaloid to 236, then yellow and epidotic again, then massive faintly ophitic (3 mm.) with much feldspar and olivine at 250; near the contact at 262 are laumontite veins.
Arc. 10, -324+
Arc. 11, 108-250, 142
Arc. 12, 75-216, 141 (138)
Arc. 13, 125-265, 140
Possibly the limits of this flow in 12 should be at 92 and 232.

124. Feldspathic melaphyre, in Arc. 11, decayed and seamed. In Arc. 12, there is well-marked amygdaloid 216-222 and 232-237; below faintly ophitic.
Arc. 11, 250-302+? (52?)
Arc. 12, 216 or 232-280? (64?) or (48?) cut by vertical fissures with calcite and *copper* (63)
Arc. 13, 265-313, (48)

125. Feldspathic melaphyre, with occasional epidote streaks and a fine grained, black and white amygdaloid at the bottom in Arc. 12.
In Arc. 13, coarse amygdaloid with *copper* and calcite vein and fissure about 332-337
Arc. 12, 280-342, 62 (61)
Arc. 13, 313-349+

Below the base of Conglomerate 8 (804)

126. Porphyry conglomerate, with pebbles of all kinds and apparently if the dip of the hole is 45°, a dip of 59° to 62°. There is much matrix. I take this as conglomerate (6) which Marvine's makes (736) feet below No. 8 on the Isle Royale Consolidated property, Hubbard (722). I think that this rather than the one below is the one which outcrops on Section 20, as Hubbard says not over 350 paces (1000 feet) horizontally from No. 8. Omitted by Pryor.
Arc. 12, 342-353, 11 (11)

Below the base of Conglomerate 8 (815)
This would be horizontally 975 feet.
This will be less if the dip is less than 56.5°; more if it is greater.

127. Amygdaloidal melaphyre. Amygdaloid begins well-marked with small amygdules, then at 364 a clay seam. The samples remain amygdaloid and full of fissures to the end of Arc. 12 with brecciated or scoriaceous conglomerate which as Hubbard remarks (p. 134) are characteristic below No. 6 conglomerate.
Arc. 12, 353-408+, 55+ (54)
Hole 14 is planned just to lap this on a 56.5° dip.
It does not begin in the same kind of rock but in a fairly compact rock with a streak of epidote and COPPER at Arc. 14, 32.

128. Melaphyre. Feldspathic, compact with long cores, black, faintly ophitic and without amygdaloidal contact on the conglomerate.
Arc. 14, 40-70, 30 (29)

129. Porphyry conglomerate, various kinds of pebbles, with an epidote and calcite cement. This may be conglomerate (5), which Marvine makes 292 feet below No. 6, but might conceivably be the one above repeated by faulting.
Arc. 14, 70-80 (10)
Below the base of Conglomerate 8 by scaling from Pryor's section (1010)

Below the base of Conglomerate 6 by scaling (160)
But there was an error in platting the position of Conglomerate 6.
We shall take it as below Conglomerate 6 (140)
And below Conglomerate 8 (955)

But there is an uncertainty of some 50 feet independent of what may be produced by faulting.
Cf. Isle Royale bed 31, with which it closely agrees.

130. Amygdaloidal melaphyre, dark with small white amygdules.
Arc. 14, 80-97 (17)

131. Amygdaloidal melaphyre, dark with small white amygdules, with some laumontite, sometimes chocolate, in spots epidote.
Arc. 14, 97-130? 33 (32)

132. Ophite. From 150-170 with fine grained mottling.
Arc. 11, 130-140 am-179, 49 (48)

133. Melaphyre, amygdaloid and pseudamygdaloid, ophite at 306 (4-5 mm.) perhaps more than one flow.
Arc. 14, 179-323, 144 (141)

134. Basic (Amygdaloidal or Scoriaceous) conglomerate in Hole 14 more scoriaceous; in Hole 15 more plainly a basic conglomerate.

Arc. 14, 323-340? (17)
Arc. 15, 91-101 (9)

Below Conglomerate 5 (255)
" " 6 (395) ft.
" " 8 (1210)

The correlation of these two beds implies either a dip of only 51°-52°, or faulting amounting to not over 35 feet or (and in view of the strikes on Section 29 this seems quite possible,) a veering in the strike reducing the distance between the holes at right angles thereto.

135. Ophite, scoriaceous on top with a very well marked decrease of the mottling below, at:

125, 132, 141, 142, 148, 161, 168, 171, 186, 191, 211 feet, there are
Mottles 2, 3, 4, 3-4, 4-5, 2-3, 4-5, 5, 3, 2-1, ⅓ mm.

There is a curious band just below.

Arc. 14, 340-363 scoriaceous -363+
Arc. 15, 101-112 Amygdaloid -212 (109)

136. Scoriaceous amygdaloid; scoriaceous, brecciated on top, with a seam of epidote and *copper* at the base, possibly belonging to the ophite below.

Arc. 15, 212-248, 36 (35)

This and the belt 109 feet above are about the same level as a scoriaceous conglomerate in the Atlantic cross-cut assigned to cg. 5? and about 630 feet below 6? But cf. also Belt 139.

These scoriaceous tops occur all along here.

137. Ophite, the top seamed and banded, the base a well-marked dark ophite. At 314, 2 to 3 mm., at 325, 1 mm., at 327 contact.

Arc. 15, 248-327, 79 (77+)

138. Ophite, marked for so small a flow; at 334, 2 mm., at 344, 1 mm.

Arc. 15, 327-331 Amygdaloid -355 (28)

139. Ophite, with characteristic scoriaceous top, at:

370, 379, 389, 402, 433, 443, 448, 453 feet
1, 2-3, 2½-3, 3-4, 3, 2, 1-2, 1-½ mm. mottles

Arc. 15, 355-364 Amygdaloid 459, 104 (102)
Arc. 16, 63- 92
Cf. the bed at the top of Isle Royale mine d 11

Below Conglomerate 5 (513)
" " 6 perhaps (663)
" " 8 " (1468)

140. Basic, amygdaloidal or scoriaceous conglomerate. Number (4)?

This may be correlated with the first conglomerate on the Atlantic cross-cut to the northwest 18 feet across, there provisionally correlated with Marvine's No. 4.

Arc. 15, 459-483+, 24 (24)
Arc. 16, 92?-115? 23

Hole 15 shows the "characteristic amygdaloid conglomerates" below Conglomerate 6 very well. They are intimately associated with well-marked ophites, and the scoriaceous character seems to be associated with the more augitic flows while the more feldspathic are more coarsely amygdaloid throughout.

Arc. 16 begins in an ophite that is growing finer and at Arc. 16, 92? passes into a scoriaceous brecciated bed like that at Arc. 15, 45-9. This correlation fits perfectly with the correlation of Arc. 14, 340 and Arc. 15, 101, and implies a dip of 51° if there is no change in strike or dip. It would require a change of 27° in strike to produce the effect of apparently flattening the dip from 56° to 51°, but the conglomerates on Section 29 seem to veer nearly that much and strike nearly N. 63° E. In case the direction of the drill holes is that much out from being at right angles to the strike the thickness should be reduced about one-tenth, to about nine-tenths of their present value. While I think some such correction is needed the amount of this correction is so uncertain that I have not done so, and in Hole 16 no correction has been applied to the beds at all.

Below Conglomerate 5 (537)?-10%
6 (677)?-10%
8 (1593)-?

140A. Fault clay, red clay and scoriaceous top of belt below.

At Arc. 16, 115 is a red clay sludge under which is a mixture of fine grained trap and scoria, and from 124 to 134 it continues rather soft and clayey. At 142 it is a fine grained and laumontitic trap. At 153 there are fragments of scoriaceous conglomerate and red mud and again at 192 feet, so that the boundaries of the belts are very arbitrarily taken.

141. Ophite, crushed, with scoriaceous trap?

Arc. 16, 115-124, 109? 109?

142. Ophite with scoriaceous top, decomposed and fissured down about to 240.

At 257, 274, 284, 306 feet
Mottlings of 2, 3-4, 3-4, 3 mm.
Arc. 16, 224-314 90

143. Melaphyre, with 9 feet amygdaloid, tends to be a fine grained trap, faintly ophitic at the base 371.

Arc. 16, 314-375 71
Below Conglomerate 5? (797)-10%
" " 6? (937)-10%

144. Ophite with scoriaceous top (practically basic conglomerate) down to 394; at 417 there is red sand and at 429 feet 1 foot of red clay (fluccan). Cf. perhaps Isle Royale consolidated Bed 43.

At 430, 444, 456, 471, 499, 504 feet
The mottles are 4-5, 5, 5, 9! 2-3, 2 mm. across
Arc. 16, 375-515 140

145. Ophite, amygdaloidal top only.

Arc. 16, 515-533+

146. End of Hole 16.

Below Conglomerate 5, probably not far from (945)-10% ft.
" " 6, " " " " (1095)-10%

The end is probably about 600 feet or more above the horizon of the Baltic lode.

The Arcadian section thus covers the whole of the Central group. I estimate about 479 feet in 8,500 or 1 foot in 18 or 5.65% is sediment, as against 415 feet in 6,247 or 6 feet in 15 or 6.65% on the north shore of Lake Superior (in Isle Royale). The section of the beds above through the Ashbed and up into the Eagle River series

is given by the sections in Volume I, grouped as XV and has been further explored by recent drilling of the Franklin and other companies.

The Arcadian section above given also goes quite a distance into the Bohemian Range group but not, as I believe, to Marvine's Conglomerate 3. The Arcadian was, however, reorganized and the New Arcadian drilled and has put in a shaft and cross-cut farther east in Section 29. (See Pl. IX.)[1] Taking the Central group alone it is interesting to compare this section with Manitou 7. We have 90 beds here as against 115 and perhaps a few more there. We have the Greenstone practically run out here, whereas from No. 9 conglomerate to No. 8 is practically constant when we allow for the fact that faults are likely to disturb both series—3,015 feet here as against about 2,800 feet there. In both cases, and all along the range, the amount of sediment is almost inappreciable. The succession of beds must have been very rapid. This is the last really complete section of the Central group until the Winona. From this point south the center of interest and exploration has shifted lower down—to the Bohemian Range group. That there is any reason for this in the distribution of the copper itself may be doubted, since it may be explained by the depth of glacial covering, and the accidents of development.

§13. QUINCY-HANCOCK (FIG. 43.[1])

The various sections of XV of Volume I lead us from the Franklin Junior and Arcadian to the Quincy and Hancock mines which overlook Portage Lake. This winds like a river through the range but does not seem to mark as a whole any profound break.

There is some uncertainty in the section near it owing to possible faults, but the upper beds have been well exposed.

The Swedetown Creek section exposes what seems to be the Freda sandstones. These are underlain by the Nonesuch shale group, a series of alternating brown or green flags and green to black shales, quite micaceous and exposed near the powder houses with about the same strike and dip. Then succeed the "Leopard" sandstones of the Old Hancock quarry. This seems to be the same series exposed in the creek near the Old Atlantic stamp mill opposite or lower if anything. On the average these beds dip 23° 30′ to N. 51° W., at which rate the mile covered would not amount to more than (2,100) feet.

We next come to a series of conglomerates and amygdaloids

[1] In envelope.

exposed in the Hancock vertical shaft and on the hillside near it. So far as I know no trap or amygdaloid occurs above the beginning of this shaft.

The Hancock vertical shaft begins in

Conglomerate No. 22 of Volume I, Plate XIX	210 feet
Amygdaloid	5
Trap	
Conglomerate No. 21 and sandstone to	291

dark red with much basic matter (1 mm. conglomerates or arkoses).

This will include, then, Marvin's conglomerates 18-22 which correspond to something like (1,200) feet of thickness according to the mean dip and should bring us down to the Hancock vein of the No. 1 shaft and of Volume I, Part II, page 83, the second amygdaloid (93) feet under the Hancock west conglomerate No. 17, just about the horizon of the old Atlantic mine. A number of sections from No. 17 down to the Pewabic lode are given in Volume I. (See also the Arcadian section, and I believe various cross-cuts have exposed it since.) The Hancock vertical shaft and various cross-cuts thereto will well expose this part of the section. Figure 43 gives a cross-section of the Quincy mine long cross-cut into the foot. The ventilation in part of this was not good, and the fumes of nitroglycerine gave me a sick headache, so that I do not feel as much confidence in this section as in some.

Sp. 17999 is from a drill hole a short way into the hanging of the Pewabic lode of the Quincy mine. The augite is in patches or interstitial areas may be of polysynthetic individuals. The average diameter of these patches is 1.3 mm. The plagioclase seems to be between Ab_3 An_1 and Ab_2 An_1 and is therefore oliogclase. Compound albite Karlsbad individuals are grouped together and are 1 to 1.2 mm. long by 0.3 mm. wide. The olivine is conspicuous and is about 0.75 mm. across. The chlorite is in botryoidal aggregates filling the cavities. The spherules show strong dispersion and the extinction is sometimes plus and sometimes minus. The thickness of the section judging from the retardation of about 400 for augite and 111 for feldspar is .017 mm. The chlorite seems to have a birefraction of about .018. It seems to be copiously mixed with zoisitic epidote whose refraction is greater than augite and about like chlorite. The olivine is all changed to iron oxides and green chloritic or serpentine substance.

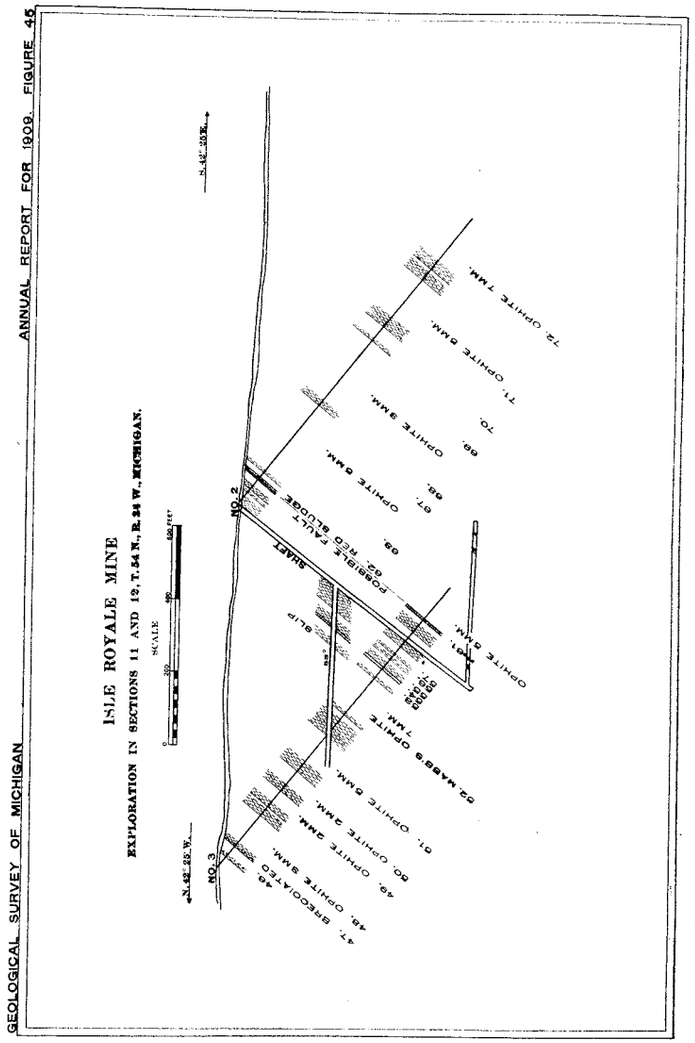

Figure 45 Geological section of Isle Royale mine showing work in Section 12, R. 54, R. 34.

§ 14. ISLE ROYALE CONSOLIDATED MINING COMPANY. (FIGS. 44 AND 45 AND Pl. X.)

Overlooking Portage Lake, the town of Houghton and the College of Mines are bluffs on which stands the property of the Isle Royale Consolidated Mining Company. The following section from their notes is one of the most detailed of the Bohemian Range group below Conglomerate 8. It is an important section because

just here the numbers to Conglomerate 1 to 8 were first assigned.[1] The section is practically complete and continuous with the exception of a small gap below Conglomerate 8, which we have patched in as shown. It is noteworthy in that this is the first extensive section in the Bohemian Range group since the Mendota and Montreal. There is a heavy ophite at the Montreal 1,608 feet down and one here about 2,000 feet down. Here it is not over 400 or 500 feet more to the Baltic conglomerate 3, while in the Mendota section it is 1,400 feet from the first ophite to the Lac la Belle conglomerate. If, however, we suppose the very thick ophite just above to be the Mabb Ophite we might get nearly accordant figures. There seems to be no reason why the Lac la Belle conglomerate may not be the same as the Baltic, and the mining done on Sections 31 and 32, T. 58 N., R. 29 W., and Sections 35 and 36, T. 58 N., R. 30 W. be at a horizon not far from that of the Baltic lode, though largely on fissure veins, to be sure.

The detailed record of the work around Houghton follows and is illustrated by Figure 44. The section (above) is pretty well completed by exposures in Houghton, studied in Volume I of these reports.

GEOLOGICAL CROSS-SECTION AND COLUMN OF THE ISLE ROYALE CONSOLIDATED. (FIGS. 44[2] AND 45.)

Abstract. *Isle Royale drill hole 4.* Paralleled by Holes 5, 7, 8, and holes from drifts in the mine, e. g., 5. 13 level S. of No. 2.

Beds 1-8 Feldspathic ophites and melaphyres
No. 3 is hanging of Isle Royale lode,—above No. 8 (483)
Bed 9. *Conglomerate 8* d 4. 990-1024 d 5. 995-6
Beds 10-17. Unexplored gap. Conglomerate 8 to drill hole 12.

Isle Royale drill hole 12.
Beds 18-21. d 12. 1-148
Bed 22. *Conglomerate* 6 d 12. 148-150
Base below Conglomerate 8 (721)
Beds 23-30. Amygdaloids and small feldspathic ophites d 12. 150-12. 365
31. *Conglomerate* 5, d 12. 365-387 (23)
Base below 6 (237)
32? and 33. Amygdaloid conglomerate -437 (50) 73
34. 5 mm. ophite (69+);
(35 & 36) 5 mm. ophite (85);
37. (4 mm?) ophite 100?; d 12. 692 and d 11. 88
Base of Hole 12 below 31 (no allowance for faulting) (305)
Ophites show mottles down to 1 mm. and less.

[1] Vol. I, Pt. II, pp. 62-63, table p. 60. Pls. XIV to XIX.
[2] Fig. 44 is in envelope.

Isle Royale drill hole 11. Laps No. 3 at bottom. 395 feet below base of a conglomerate outcrop, which is 31-33.

38. *Marvine's* Conglomerate 4 (12) d 11. 88-100
Base below base of 22 (552)
38. A. cg. & 39 3 mm. o. (90); 40 and 41 2 mm. o. (84); 42 2 mm. o. (64); all small ophites with A. cg. top.
43. Felsitic conglomerate d 11. 346-368 trace of copper.
Base below base of 38 (268)
44. 2 mm. o. (36?); 45 A. cg. & 46, 3 mm. o. (75); 47 A. cg. & 48 5 mm. o. (95); 49 to d 11. 574
49. d 11. 574 to 499; d 3. 180-274; d 9. 15-62 (94)
Base below base of 38 (568)

Isle Royale drill hole 9. Laps 3, 13 and 14 in part; crosses Mabb ophite.

50. 2 mm. o. (65); 51 5 mm. o. (115) to d 9. 232 and d 3. 463 below base of 38 (748)
52. *Mabb ophite* 8 mm. d 9. 232-451, d 3. 463-706, d 14-172, d 13. 400-513 (219+)
below base of 38 (969)
55, 56, 57, 58. Feldspathic melaphyres to d 9. 550
Base below base of Mabb ophite (99 to 183)
59. Signs of copper common horizon of Baltic lode
60.
61. Baltic conglomerate No. 3, d 9. 614-685; d 3. 879-891; d 14. 282-373 (71)
Base below base of Mabb ophite (234)
" " " " Bed 38 Cg. (4) (1201)
" " " " " 22 " (6) (1753)
Possibly repetition of 31 to 33
62. (29);
63. 2 mm. (66);
64. S. cg. and 65 2-3 mm. (49)!?;
66. (36);
67. (33);
68. (4 mm.) 226?
69. 1 m. (20);
70. 1 mm. (30);
71. 5 mm. (173);
72. 8 mm. (213); above beds appear to be 41 to 52 repeated faulted.

Isle Royale drill hole 4. At an angle of 34°. Elevation about 930 above tide. 300 ft. E., 500 ft. N. of the W. ¼ post of Sec. 11-54-34. The indications on the sandstone conglomerate seams at the bottom and the epidotic seams at 747 ft. etc., are that the hole cuts the beds at an angle of about 64°; and a steeper dip than at right angles to the hole is required in order to make the correlation with the lode in shaft No. 6 and the conglomerate 860′ S. of the W. ¼ post of Sec. 11. Assuming the beds cut the hole at 64° we have to take .9 of the width for the thickness. This would, however, imply a dip for the beds of 71° which is too great. The true thickness is probably somewhat greater.

1. Feldspathic ophite (74+) (100?)
Trap d 4. 50-124
Fine grained at first; coarse feldspathic, 2-3 mm. mottles at 60-85, with an amygdaloid inclusion at 85, then darker, harder, finer. This may also be the first bed in No. 5, but there the glomeroporphyritic base is much more distinct, small 1-2 mm. epidotized greenish feldspars occurring on a red ground, and it is possible that a fault crossing No. 5 has brought in higher beds. Cf. Bed 92 in the Arcadian section, about 2,000 ft. below the Wolverine sandstone, Marvine's Conglomerate 9.
2. Feldspathic melaphyre (108)
Amygdaloid d 4. 124-135
Slightly porphyritic. Cf. No. 5. 87-104
Trap d 4. 135-244
Occasional pink amygdules of prehnite (?) and green flinty inclusions. The mottling at coarsest is very vague, though it can be seen to grow finer toward the base. Specks 2 mm. across of altered olivine are plentiful. Hole 5 is in the same belt perhaps between d 5. 124 and 240. Between 240 and 248 there is, however, a marked slip and this may be some higher bed. It is characteristic in No. 5 that the feldspar laths are long (2 mm., in one case 10 mm.), the chlorite flecks plain, and the core long, with epidote seams and signs that the dip is nearly vertical.
3. Feldspathic ophite (184)
Amygdaloid d 4. 244-254
Coarse, poor. Cf. Hole 5. 240-248
Trap d 4. 254-449
The augite mottling is faint: at 278, 314-354 ft.,
the grain is 2-3, 5-7 mm.
The feldspar is at 436 ft. 1-3 mm. long.
The olivine is at 314 ft. 0.5 mm., above 436 ft. 1 mm. and conspicuous.
Toward the base the hard, dense, *faintly* mottled trap with long cores is characteristic. Cf. Winona d 10. 484-615. Between 441 and 445 there is a slightly amygdaloidal seam. This heavy bed is the well-marked hanging of the Isle Royale lode, coming between it and the Grand Portage[1] in section 11, 18+81 ft.
It is well shown in Hole 8. 1-226, where also the mottling is from 5-7 mm., and in Hole 5, 240-435, with mottling

at	243,	348,	400,	405,	422 ft.
respectively	1,	7,	3,	1,	0 mm. across

Base of top of Isle Royale lode to top of No. 8 conglomerate (482)
Cf. Hubbards (542) to base, and Marvine (pp. 65-66) 10+355+7+150+ =512+
It is probable that we have used a little too large reduction factor.
4. Feldspathic ophite. Isle Royale lode and foot. Arcadian (96)
(probably a gush of the overlying). (84) to (93)
Breccia d 4. 449-455
This is the Isle Royale lode. There is copper at 440. In No. 5 the copper is at 446. It is fine grained, red glomeroporphyritic, like numerous holes in the mine running into the foot.
Trap d 4. 455-542

[1] Marvine, p. 64, the abundant small flecks of red mica of Marvine, rubellan of Rominger, V, p. 94, 114, are the altered olivine.

Faintly ophitic from 1-2 mm. at 490, up to 3 mm. at 495, then finer. A number of holes show up this. Hole 5 of 13th level, S. of No. 2 shaft shows a faintly mottled trap 3 mm. at 30, at 78 to 90 2 mm., with epidotic amygdaloid. In general the mottling gets up to 2 to 3 mm; not more, and there are prehnite bands and amygdaloid inclusions. Hole 5 on Sec. 15 is ophitic from 464 on but faintly,—2 mm. at 500. The feldspar is 0.5 mm. and the hand lens shows altered olivine. From d 5. 517-548 appears a separate flow. From d 5. 517-579 a gray amygdaloid with laumontite and calcite amygdules, then a fine trap with 2 mm. feldspar and epidote seams at 31° to hole (71° dip) and occasional amygdules 1 mm. across. Marvine's Section 11 makes this 15 to 50 lode + 69 melaphyre.

The marked red-brown character of the amygdaloid underlying it, that is the top of 5, is noted by Marvine.

5. Feldspathic ophite (160) to (180)

Amygdaloid d 4. 542-550

Marked, red. Cf. No. 5 at 516 ft. Also No. 5, on 13th level. S. of No. 6 shaft 78-90.

There are other streaks of amygdaloid at 561-567, and 583-585, with occasional coarse pink radiating prehnite (or thomsonite) amygdules to 594.

Trap d 4. 550-722

With chloritic specks. The mottles are—

at 594–612, 622–658, 686, 707 feet.

about 2–3, 5 5–7, 2 mm. across.

The decrease of mottling from 686-722 is quite uniform. Drill hole No. 5 has a poor amygdaloid at 548-551, and occasional coarse, large, pink and green (thomsonite or) prehnite amygdules to 571, that is for the upper 55 ft. corresponding to d 4. 542-594, then faintly mottled to 591, then a green amygdaloid d 5. 591-594, then occasional green and white specked large amygdules and a fine grained trap to 613, then green and white hard amygdaloid and inclusions to d 5. 613-617, then fine grained, hard feldspathic trap to 634, then veined at 59° to 42° to the core, with amygdaloid specks and faint 2-3 mm. mottles

At d 5. 687, 688, 691 feet

the grain is 3, 1–2, 3 mm. respectively the base being at 706 feet.

Then to 709 a poor amygdaloid, then a coarse feldspathic ophite whose grain at 755 and 761 feet attains 5 mm., 8 x 4 mm. respectively.

It is quite clear that this does not match No. 4 closely and either there is a rapid change in the beds or the section is somewhat disturbed by proximity to the fault on Sec. 16. This latter supposition is probably true and according to the mottles d 5 at 755 might correspond to d 4 either at 686 or at 780.

It will be noted that Marvine reports an amygdaloid 150 ft. below the Isle Royale lode.

6. Feldspathic ophite (128) to (115)

Amygdaloid d 4. 722-730. Cf. d 5. 706-709

Marked, poor; amygdules greenish white and gray.

Trap d 4. 730-850 d 5. 709 to 725-848

Chloritic specks, epidote seams at about 64° to core. There are faint, coarse 5 mm. mottles at d 4. 780 which are comparable with 5 mm. mottles at d 5. 755. This may be two close following flows or gushes of the same flow, for at d 4. 801 it seems finer and there is an amygdaloid inclusion and at d 5. 778-781 is a coarse amygdaloid and at d 5. 783-785 is a prehnitic amygdaloid. The feldspar is about 1 mm.

7. Feldspathic ophite (113) to (101)

Amygdaloid d 4. 850-853; d 5. 848-853

Dip of amygdaloid bands 37° against core. All these amygdaloids are of one type, thin, gray, hard siliceous, coarse with large amygdules.

Trap d 4. 853-963; d 5. 853-969

Coarse massive trap, the faint ophitic mottling hardly visible; estimated at 5 mm. at d 5. 947

8. Feldspathic ophite (27) to (24)

Amygdaloid d 4. 963-975

Coarse white and gray amygdaloid

Cf. both d 5. 985-8 and d 5. 969-973

Trap d 4. 975-984; d 5. 973-985

Mottling coarse and faint

Amygdaloid (base above conglomerate) d 4. 984-990;
d 5. 985-995

Cf. Arcadian 105

END OF CENTRAL, BEGINNING OF BOHEMIAN RANGE GROUP.

The beds of Winona drill hole 10 match, (being feldspathic ophites or melaphyres with a glomeroporphyritic margin), these beds above conglomerate 8, and the green and white amygdaloid tops and inclusions hard to distinguish from them are like those met in Arc. d. 3.

9. *Conglomerate* 8. (34?) or (30±)?

d 4. (984 or) 990-1024. d 5. 995-6

From 984-990 is a transition to an epidotic conglomerate, the pebbles of felsite are also well marked. There are also sandstone beds which dip (co. 29°, 26°, 24°) about 65° against the core, suggesting that the hole may have flattened a good deal, and the correlation with No. 8 conglomerate in the west line of the section 860 S. of the ¼ post also suggests either this flattening or a steeper dip. There may, therefore, be a deduction of not over 10% to allow from the thickness. Base below top of Isle Royale lode (542) to (482)

This is a conspicuous datum plane, being the first important conglomerate for over 2000 feet, and is identified as the first below the Arcadian lode, and also the first below the Winona and King Philip. It is characteristic that the beds in the neighborhood have a rather feldspathic habit, and when they show the ophitic mottling the pattern is faint and can generally be recognized only in the large flows, not in the smaller sizes in which the augite patches are all cut up by the feldspar. Coarse amygdaloidal spots with pink prehnite are, as Pumpelly remarks, also characteristic.

10.

Amygdaloid d 5. 995-1017+

None of the recent Isle Royale Consolidated holes show the section between Conglomerate 8 and Conglomerate 6 completely. According to Marvine this is 896=566+332 or at a 55° dip (736)=(464)+(272) ft. Hubbard says 860 or (722) at a 57° dip.

But we may patch up the probable section in detail as follows, using the earlier explorations, and other records.

9. Conglomerate 8. Arcadian 106. Marvine p. 68. Yielded some copper. Cross-section II h (12)
Covered in II h (168)

10. Just entered in Hole 5 (85)
(covered in II b) 85
Arcadian 107 is a doleritic ophite d 9. 133-266 (130) ft.

11. Amygdaloid (II b, notes of A. B. Wood) (5) (85)
(covered in II b 85)
Arcadian 108 is a clasolitic melaphyre, feldspathic
Arcadian d 9. 266-293 (26)
"Ancient Pit" or "Foster Mass" Amygdaloid II h, II i 17 (117)

12. Some copper found; brecciated in appearance, with quartz, prehnite and calcite filling the cracks, many ancient workings. It is thus 168 to 175 ft. below Conglomerate 8.
Covered in II h are 102 ft. to Capen vein
Covered in II b are 255 ft. to 24 ft. of conglomerate with sandstone on the upper side.
Arcadian 109 is a melaphyre, gray, green and epidotic.
Arc. d 9. 293-310 (17)

13. "Capen vein"[1] Foot 3+ (50?)

14. Ophite. Arcadian 111 is a marked ophite with ½ mm. mottling (103-)
at Arcadian d 9. 335-365 (27 ft)
Marvine's section IIg shows two belts of "slightly shimmering" compact dark trap, with considerable magnetite, beneath the Capen vein, the second 75-125 ft. below. These same minutely mottled ophites occur on the north line of Section 1, well exposed near Agate St.
Arcadian 112 is a seam of sediment of basic sandstone or shale, only (227) ft. below Conglomerate 8. It is probably intimately connected with Arc. 114, an epidotic sandstone, though separated by Arcadian 113 d 3. 365-395+

15. Conglomerate (IIb) No. 7. (24)
This appears to be unusually thick
Base below base of No. 8 according to Marvine (464) ft.
See also Hubbard p. 108 and 107 510 ft. horizontally or (420)+
Cf. Arcadian 114 at d 10. 40-43
In section (II b) the next interval below Cg. 7 is covered (260) ft. down to a 3-foot conglomerate, which is supposed to be (6), so that we can not exactly tell what the intervening beds are except as the new Hole 12 informs us.
Below No. 7, i. e., Arcadian 114, there follows in the Arcadian section a series of 8 thin amygdaloidal and glomeroporphyritic flows, and three fair-sized feldspathic melaphyres; in all 804-267 (537) ft. These are not unlike the beds at the top of Hole 12, but the record probably is disturbed

[1]Marvine II h and II g apparently a fissure vein? "Seams of calcite, prehnite, laumontite and fibrous chlorite with flakes and sheets of copper."
Arcadian bed 110 a marked ophite (more so than for a long distance above) the mottling showing clear down to 1 mm., the top brecciated and reminding one of the ancient pit. The melaphyre of the Capen vein is also an ophite, and minute mottling may be seen on the N. line of Section 1.
The Capen vein may cross not only this amygdaloid, but further north Conglomerate 7. See Hubbard, Volume VI, Part II p. 132.
Underneath (II g) is a melaphyre "shimmering,"—an ophite, dark, compact, and with magnetite, apparently a heavy bed.

by faulting. Marvine's section II. g also shows only 2 fine grained amygdaloids in its lower part down to 250 below the Capen vein (205).[1] Marvine gives a conglomerate about 500 ft. horizontally below (410) the Capen vein, which should accordingly be (410-50-103) (257 ft.) below No. 7. In IIb the interval is (260) ft. Hole 12 begins 140 ft. (less 15 ft. overburden) above No. 6, and shows three beds in these (125) feet. There may be something like 7 beds then in the interval between Conglomerate 7 and 6 which seems thus to be characterized by small feldspathic beds as follows:

16. First amygdaloid below Conglomerate 7 (Marvine II g) shows stains of copper carbonate 50±
There is some copper at about this level at the Arcadian in beds 115-123.

17. Second amygdaloid below Conglomerate 7 (II g) green, silicious, chloritic. 50±

18. Is Isle Royale d. 12 15-50 (Amygdaloid above hole, trap) 57±

19. Is Isle Royale d. 12 50-63 amygdaloid, -68 trap 18

20. Is Isle Royale d. 12 68-72 amygdaloid, -120 trap 52

21. Is Isle Royale d. 12 120-135 very epidotic amygdaloid, -148 trap 28

22. Is Isle Royale d. 12 148-150 felsitic, epidotic conglomerate d 6 2

Base from base of No. 7 about 257 ft.

17 and 18, may be the same bed. 16, 17 and 18 are not represented in the cores.

Isle Royale drill hole 12. At an angle of 35°. Elevation about 950 above tide, 700 ft. S., 300 ft. E. of the S. ¼ post of Section 1-54-34. About 1290 ft. across the strike from the Isle Royale lode; it should accordingly be about (1060) ft. beneath it or (518) ft. below the base of No. 8 and (722)-(518)=(204) feet above Conglomerate 6. It ought, then, according to Marvine's II b section to miss Conglomerate No. 7 by only 54 feet or so[1]. The 2 or 3 feet of conglomerate in it at 148 feet, (194) feet or so beneath, would then be the next, i. e., No. 6, which Marvine makes only 3 feet thick. The interval from 7 to 6 Marvine gives as (250) to (272) feet, however, which is considerably greater.

18. Feldspathic melaphyre d 12. 15-50 (57+)
Amygdaloid not exposed in the hole. Trap has 1-2 mm. feldspar.

19. Amygdaloidal melaphyre (18)
Amygdaloid d 12. 50-63
Has yellowish amygdules of ankerite, then lower of epidote then more massive
Trap d 12. 63-68

20. Feldspathic melaphyre (52)
Amygdaloid d 12. 68-72
Trap d 12. 72-120?
Feldspathic, finer from 86 down to 113. The bottom contact is so much epidotized from 113 to 125 that the dividing line is hard to fix.

21. Feldspathic melaphyre (28)
Amygdaloid d 12. 120-135
Very epidotic d 12. 120-125
Trap d 12. 135-148
Feldspathic

[1]On the E. & W. section line of Section 1. 850 ft. W. of the center is an exposure of Cg7 at just about the right position.

22. *Conglomerate 6*, of Marvine d 12. 148-150 (2)
Felsitic, epidotic, standing at about 82° to core.
The thickness Marvine makes 3 feet, struck in II b, p. 65, and 1½ feet in II which is nearer Hole 12 while it is reported only ½ inch thick further north and was apparently not noticeable in II j, etc. But it either thickens to the south or some other has been mistaken for it.
Base below base of No. 8 (721)

23. Melaphyre (20)
Amygdaloid top apparently eroded away
Trap d 12. 150-170
Specked with pseudomorphs of phenocrysts

24. Ophite (11)
Amygdaloid d 12. 170-174
Very well marked
Trap d 12. 174-185
At first fine grained, epidotic and doleritic, at 178 there are ½ mm. mottles, and thereafter it is banded with finer and coarser mottles up to 1 mm., showing apparently irregular initial distribution. This is an exceptionally small bed for a well-marked ophite.

25. Melaphyre (probably ophite) (17)
Amygdaloid d 12. 185-192
Trap d 12. 192-202
Specked and with epidotic seams

26. Ophite (58)
Amygdaloid d 12. 202-212
Very well-marked, pumiceous or frothy for four inches, then poor and mixed with flinty epidotic trap.
Trap d 12. 212-260
The mottling is distinct. At 224, 231, 243, 255 feet
the grain is 1, 2, 2, 1 mm. respectively, being coarser above 241.
Seams are numerous, parallel to the core and at 59° to it, i. e., about vertical.

27. Amygdaloidal ophite (45)
Amygdaloid d 12. 260-265
Amygdules and amygdaloidal trap d 12. 265-305
From d 12. 265-280 is a specked poor amygdaloid with small chloritic amygdules, thence to 305 is faintly ophitic and amygdaloidal or specked—it is probably near, and altered by, a fissure.

28. Amygdaloidal melaphyre (19)
Amygdaloid d 12. 305?-316
Greenish with much disseminated epidote
Trap d 12. 316-324
Specked with pseudamygdules, and with gray epidotic streaks parallel to the core

29. Amygdaloidal melaphyre (14)
Amygdaloid d 12. 324-335
Gray and white with yellow seams (of ankerite?)
Trap d 12. 335-338

30. Amygdaloidal melaphyre (27)
Quite amygdaloid d 12. 338-345
Trap d 12. 345-365

At 347-350 near a prehnite vein which is at 26° to the core, probably about vertical; brecciated at 354 also and at 357 has a datolitic look.
From 362-372 the trap is gray with yellowish specks and amygdules (ankerite?) with an indurated contact of the trap and sandstone somewhere here at about 365. Beds 27 to 30 are quite likely *not* all separate flows, but may be one general amygdaloidal bed.

31. *Conglomerate, Marvine's* 5. d 12. 365-387 (23)
Sandstone and trap d 12. 365-376
Felsitic conglomerate d 12. 376-382
Sandstone, amygdaloid and epidote d 12. 382-387
Base below base of No. 6. (237)
" " " " " 8 (958)

32. Large amygdaloid inclusion or block? about 398 (30?)

33. Amygdaloid conglomerate d 12. 417-437
With red mud matrix and black and white scoria.
Marvine makes Conglomerate No. 5 24 feet thick, evidently counting in it only down about to 387. It is, however, doubtful if the beds between 387 and 417 are an independent flow (though they may be the top of one) or only some large talus blocks, as it were, in the amygdaloid conglomerate. This horizon is notable as having beneath it the first well-marked and thick ophite for a long distance,—No. 34.
If we take this as the base of Conglomerate 5 the distance below Cg. No. 8, is 50 feet lower. This checks well with Arcadian 129. d 14. 70-80 and ophites begin pretty promptly (Arc. 132) below that.
If we count 31 to 33 together it has about the same thickness, lithological variation and small and rather feldspathic beds above and a well-marked 5 mm. ophite below that the Baltic conglomerate (No. 3) has, and it *may* be a repetition by faulting of the same bed, but there is no reason why there might not also be a rhythmical occurrence of similar conditions.

34. Ophite 4 mm. (69+)[1]
Amygdaloid merged in the overlying amygdaloid conglomerate
Trap d 12. 437-506
At 462, 469, 477, 480, 484, 487, 501, 506 feet the grain
is 2, 3, 2–3, 4–5, 3–4, (seam) 2, 1 mm. respectively.
Down to 462 is specked, decomposed. At 487 a strong seam nearly parallel to the hole may well cut out a little of the bed or have displaced a block.

35. Amygdaloidal conglomerate ? d 12. 506-510 4
A well-marked amygdaloid with yellow-green epidote sediment gradually passing into amygdaloid. This is hardly far enough from Conglomerate 6 to be Conglomerate 4, which is according to Marvine (536) feet below.
Base below base of Conglomerate 6 Bed 22 (360)

36. Ophite 4-5 mm. (81)
Amygdaloid d 12. 510-523
Transition to amygdaloid conglomerate
Trap d 12. 523-591
At 525, 530, 534-539, 544, 551, 560, 562, 565, 574, 578, 587 ft. the grain
is 0.5, 1–2, 2 , 3–4, 2–3, 4–5, 3–4, 4–5, 3–4, 2, f. g. respectively

[1]Not faulted, about (100?).

At 565 and 580 are seams at about 45° to the core, (nearly vertical probably) with prehnite, quartz and copper. Otherwise the grain is extra coarse, extra close to the bottom. This is equivalent to 26 ft. of the dark melaphyre under (358) ft. "covered" of Marvine's cross-section II.

Base below base of Conglomerate 6 591-150 (441)
according to Marvine 358+26 (394)

No. 34 may be exposed in Marvine's II e.

No. 32 is exposed in Marvine's II b, and is made about (251) feet below Conglomerate 6, (in the section on Plate XV), 361 or (292) by his table. The correlation is sufficiently close, but it is not apparent how the figures of Marvine's table which do not check so well were obtained.

Underneath this bed No. 34 begins a series of good sized ophite beds, well exposed in the Baltic location town site.

37. Ophite 3-4 mm. (101+) (90?)
Amygdaloid d 12. 591-610
Specked with pink and white amygdules on dark ground, to 594; epidotic, brecciated -604 (breccia again at 610).
Trap d 12. 610-692+
The mottling not uniform nor plain, 1-2 mm. at 653 and up to 3-4 mm?, then 1-2 mm. at 686, 2 mm. at 692. It is brecciated at 610-616, much seamed, and especially full of red slips about 671 where the alteration is so great that the pattern of the mottling is lost down to about 682 feet. While 10 or 20 feet should be added to the bottom before the contact comes it is probable, judging from the pattern of the mottles, that that would make the flow thicker than it really is, and that there is some repetition by faulting at about 671.
Bottom of Hole 12 below base of Conglomerate 6
(692-150) (542)
(34) Conglomerate 5? (692-437) (255)
Top of Hole 11 below top of Hole 12 770 or (630) ft.
The top of Hole 11 is also about 480 (395) below the base of a conglomerate outcrop, which is presumably (Beds 31 to 33). It should therefore lap No. 12 and begin in a 3-5 mm. ophite which may well be the one No. 11 ends in, that is No. 37. There is probably less faulting. In No. 11 the grain runs more uniform.

Isle Royale drill hole 11. N. W. of N. E. quarter, 3850 ft. N., 1760 ft. W. of Sec. 1, at an angle of 35°. Elevation about 900 ft. A. T.
37, again.]
Ophite d 11. 30-88 (58+)
Amygdaloid not shown
Trap (About 100)
At 30, 38, 55, 66, 75, 85 ft. the grain
is 2, 2–3, 3–5, 2, 1, 0.5 mm.
At about 55 ft. in it, it is as coarse as anywhere.
There are seams at 10° to core, and at 38 and at about 77 gaping chlorite seams parallel to core. Otherwise it is not much broken. The same bed as the bottom of 12 and the 53 and 47 feet of melaphyre, the country rock of the "New vein" in Marvine's section II+37 ft. amygdaloid?

38. Amygdaloid conglomerate d 11. 88-100 (12)
Conglomerate 4 of Marvine's Section II, who also makes it 12 ft. thick.

Base below base of Conglomerate 6, by addition (572)
from end of No. 12 (554)
Marvine (533)

39. Ophite 3 mm. (78)
Amygdaloid d 11. 100-110
There are some calcite seams
Trap d 11. 110-178
At 118, 131, 141-147, 155 164, 176, 178 ft. the grain
is 1, 2, 2-3, 5 (coarsest), 2, 0.5, 0 mm.
Cf. 17 "amygdaloid" and 23 "dark and rough melaphyre" of Marvine Section II.

40. Amygdaloid conglomerate d 11. 178-202 (24)
The matrix is red or light brown mud or calcite, with red and blue-black angular scoria.

41. Ophite 2 mm. (60)
Amygdaloid is included in amygdaloid conglomerate above.
Trap d 11. 202-262
At 215, 222-231, 240-246, 250, 255, 261 ft. the grain
is 2, 2-3, 1-2, 1, ½, ⅓ mm.

42. Ophite 2.5 mm. (64)
Amygdaloid d 11. 262-284
The contact is well marked by a brecciated amygdaloid almost an amygdaloid conglomerate.
Trap d 11. 284-346
At 288, 293, 301, 310, 315, 325, 334, 340, 344 ft. the grain
is ⅓, 1, 1–2, 2–3, 2, 2-finer, 1, ½, smaller
At 308 a vertical seam parallel to the core, probably along a columnar joint, which jointing appears elsewhere, is normally faulted by one at 70° or less to the core.

43. Conglomerate d 11. 346-368 (24)
There is copper in a little seam in a felsitic pebble of the conglomerate, which has felsitic pebbles to 351; there is an amygdaloid conglomerate to 368.

Base below base of No. 4 (Bed 38) (268)

This does not appear in cross-section II or any of Marvine's sections. He has given it no number and it occurs between 3 and 4 of his numbering. But this hole and the Atlantic cross-cut and numerous other partial sections show that there are a number of conglomerates between Marvine's Nos. 3 and 4, mainly amygdaloidal.

At d 11. 368 a seam nearly parallel to the core is crossed, with a transition to a 1 to 2 mm. ophite rather faint and feldspathic.

44. Ophite 2 mm. 368-404? (36)
At 368, 378, 385 ft. the grain is
1–2, 2, 1 mm.
At 388 amygdaloid specks and brecciated cavities with crystals occur and the contact is uncertain.

45. Amygdaloid conglomerate d 11. 404-419 (15)

46. Ophite 3 mm. (60)
Trap d 11. 419-479?
At 422, 427-432, 441, 454 464, 474, the grain is
1, 1-2, 2, ab. 3 (coarsest), ab. 2, 1 mm.
Cf. Hole 3. 33-70 (37) with a mottling of only 2 mm.
Exact base not clear (3 or 4 ft. trap at 482 ft.)

47. Amygdaloid conglomerate d 11. 479-491 (12)
With a reddish brown matrix and black and white amygdaloid pebbles.
Hole 3 at 70-86 is brecciated, noted as perhaps sedimentary, not so well-defined as in 11, and perhaps there is here something cut out by a fault.

48. Ophite 5 mm. (83)
Amygdaloid d 11. 491-502
Greenish to 497 and marked in spots
Trap d 11. 502-574
A banded ophite, bands with 1 to 0.5 mm. grain alternating and amygdaloidal about 514. It is notable that in Hole 3 I did not make the grain over 3 mm.
At 522-526, 534, 541, 545, 553, 558, 565, 567, 570 ft.
the grain averages 2-3, 3, 4, 5, 3, 2-3, 2, 1, ½ mm.

Base below base of Conglomerate 4 (Bed 38) (474)
Hole 3, 86-180 94

49. Ophite 2 mm. (92)
Amygdaloid d 11. 574-580 d 3. 180-202
Brown and white, soft, above; cold, gray, hard epidotic below, then trappy, then a streak of epidotic amygdules at 580.
This may possibly be the 39 ft. of amygdaloid of Marvine's Section II.
Trap d 11. 580-599+, 3. 202-274
Fine grained to 586, then slightly amygdaloidal with pink amygdules and streaks to 598. Cf. d 3. 224-228. At 599 is a cross-seam with quartz and prehnite, then copper and epidote of later formation.

Base of Hole 11 below Conglomerate 4 (499) ft.
The gap from d 11 to d 9 may be nicely bridged by Hole 3.

Isle Royale drill hole 9. At an angle of 35°. Elevation about 900 above tide, 1400 ft. S. and 1050 ft. W. of the N. E. cor. of Sec. 1-54-34. It should therefore begin shortly above the "147 feet covered" of Marvine's section II. It is 780 ft. (640) below 11 which it should therefore just about lap. It probably therefore begins in 50, though it may be 49.

49. (continued). 2 mm. ophite (75+)
Trap d 9. 15-52 d 3. 180-274 (94)
Begins in a 2-3 mm. ophite, jointed at 22° and seamed at 57° to the core. Finer at 40 (1-2 mm.). As the grain is decreasing the full thickness may be anything more than 70 so far as this hole is concerned, so we take it from Hole 3.

Base below base of 4 by addition (562)
or by section (594)
If the amygdaloid below is the "20 ft. of epidotic amygdaloid" of Marvine's section II the corresponding distance would be (558),—a good correlation.

50. Amygdaloidal ophite 2 mm. (65)
Amygdaloid d 9. 52-84, d 3. 274-287
Marked with white amygdules, reddish above, greenish gray epidotic below, so at 69, and then about 84 brecciated and alternating with trap. The amygdules are small. Seams nearly across the core are faulted.
Trap d 9. 84-117, d 3. 287-336
With spots of amygdaloid, with 1-3 mm. amygdules and pink and white breccia filling, containing crystals. This seems to resemble No. 49 in Hole 11 a good deal, and I should not be surprised were it the same, the repetition being due to the faulting of which there are signs. In that case the first bed in 9 would be equal to 49. They are both ophites. The match of this bed in Hole 9, so far as thickness goes with that in No. 3 (62 ft.) is very good.

51. Ophite 5 mm. (115)
Amygdaloid d 9. 117-129, d 3. 336-348
Gray, coarse, with epidote and quartz and calcite amygdules. In No. 3 it is red above, gray below.
Trap d 9. 129-232, d 3. 348-463
There are seams parallel to the core, joints across core and at 12° to it.
At d 9. 146, 156, 160, 171, 181, 187, 195, 197, 206, 209, 214, 217 ft. the grain is 2-3, 3, 3+, 3-5, 4-5, 5, 4, 5-3, 2-5, 1½, 1, 1 mm.
Below 220 it is fine grained with amygdaloidal streaks.
It is reached in the west cross-cut of Sec. 12 shaft. (Fig. 45).
Drill Hole 3. 336-463 in which the grain is also (5 mm.) a very good match.
At d 3. 362, 368-381, 394, 434, 448, 452 ft. the grain
is 2, 2, 5, 3, 2, 1 mm.

52. Mabb ophite 7-8 mm. (219)
Amygdaloid d 9. 232-236
Red and white bands nearly straight across the core.
Trap d 9. 236-451
Specked, fine grained to 244, then rather coarser, but at 260 a rather sudden combination of coarse 7 x 4 mm. mottles and white amygdules, the trap epidotic, then specked finer and redder, the mottles irregular, in spots coarser, some seaming parallel to the core at 277 but no obvious great jump. There is a datolitic look near 281 and specks of copper in an amygdaloid seam. Seams and joints occur at right angles and nearly parallel to the core, also one at 64° and one at 59° are cut by one parallel to the core or vertical. Near d 9. 312 the mottles become coarser and more settled, so that for the lower half the grain may well be made out thus:
At 312, 316, 326, 331, 339, 345, 354, 360, 367, 383, 395, 404, 413, 422, 428, 433, 451 ft.
7-8, 7, 8-9, 7, 7 (5-10), 5, 5-7, 5, 5, 4-5, 3-5, 3-4, 3, 2, 1, 0.5, base
This heavy and coarse ophite is a fairly good datum plane down to the Baltic location. Possibly it continues north to the Mendota.
Cf. in Hole No. 3 463-706=(243)
14 top down to 131 or 172
13 from 400 to 513, part removed by a fault.
In the Superior trench it was exposed 600 ft. east of the center and 300 ft. S. and at the Baltic location close to the Mine office.

It is exposed in the old Mabb workings and dump and along the N. line of Sec. 6-55-33 and the 8 mm. mottling is plain, being beautifully brought out in slightly weathered masses from the old dump. It is also exposed in the N. W. end of the trench which runs N. W. from the S. E. corner of the S. W. ¼ of the S. E. ¼ of Sec. 11-54-34, and elsewhere. See Rominger Vol. 1, p. 112.

Base below base of	(50)	d 9. 15-52	(399) ft.
" "	(38)	4 at 11. 100	(967)
" "	(31)	5 at 9.387	(1248)
" "	(22)	6 at 9.100	(1535)

At the Baltic location this distance seems to be about (1620) feet depending somewhat upon the exact dip assumed.

In the west cross-cut of section 12 shaft (Fig. 45) all above 165 feet from the shaft, or say 190 from the foot of the shaft to 440 ft. is the ophite, the top amygdaloid being about 40 ft.; at 222 ft. in the grain is about 7 mm.

Here and in No. 3 hole, however, a small bed of ophite (d 3. 673-706) 33′ intervenes between the Mabb ophite and the sandstone bed 54, but in the cross-cut at the top of the 44 (34) feet between the basic sandstone and the base of the Mabb ophite is a strong fluccan seam, dip 63° strike N. 50° E, the dip somewhat steeper than the formation.

Such a seam acting as a slide plane might easily cut out of the record the bed in No. 9 or may introduce an entirely new repetition of beds, by which for instance 54 would be equivalent to 38.

53. 2 mm. ophite (33)
Amygdaloid I. R. d 3. 673-679
Amygdaloidal trap d 3. 679-686
Trap d 3. 686-706
1-2 mm. mottles at 694
Drill hole 3 is horizontal into the hanging from the mine, lower level has 166-194 trap and at 207-209 amygdaloid.

54. Basic conglomerate d 9. 451-453 sandstone (2)
The dip is about 64° against core,—very likely it is nearly vertical. There is only a little of this but it is quite persistent. Cf. d 14. 131-141 and 172-3 d 3. 706-722 and the bed about 100 ft. (80 above) N. of Sec. 12 shaft in the west cross-cut. It appears also in horizontal drill hole 3 from the level where it comes at 161-166, dip at 59°; also horizontal drill hole 2 at 152-162. There are seams at 72°. Cf. also the conglomerate in the Superior trench 590′ from the N. W. end.

55. Feldspathic melaphyre (18)
Amygdaloid d 9. 453-456
At 456 an epidotic, clasolitic seam.
Sample of water (1.) from this. See Chapter VII.
Trap d 9. 456-471
Fine grained, but with feldspar 1 mm.
Cf. d 3. 722-743 (21)
From 148-161 is coarse greenish amygdaloid with pink amygdules.
Also d 14. 141-172
55, 56, 57 and 58 are all small flows, feldspathic (feldspars 1 mm.) and closely allied, resembling the beds above 31 and 22, Conglomerate 6 rather than the ophites which are common below. I should not be surprised to find that 54 was Conglomerate 6 repeated by faulting.

56. Melaphyre (15)
Amygdaloid d 9. 471-482
Red and white, markedly prehnitic.
Trap d 9. 482-486
Cf. d 3. 743-752 (9)
The horizontal drill hole 3. 161-115 seems to correspond to 55 and 56.

57. Feldspathic melaphyre (14)
Amygdaloid d 9. 486-494
Reddish at top, greenish at bottom.
The reddish basal amygdaloid is glomeroporphyritic like the bed under the Isle Royale lode with small 1 mm. green feldspar crystals on a red ground. The same occur in horizontal drill hole 3 at 24, 58, and 77.
Trap d 9. 494-510
Coarser with occasional red bordered or green light amygdules to d 9. 502 ft. then finer. From 44-77 above the Sec. 12 shaft or 100′ from the foot wall.
Cf. d 3. 752-790.

58. Amygdaloidal melaphyre (9)
Amygdaloid d 9. 510-519
Upper contact uncertain, perhaps part of 57, coarse.
Compare d 3. 790 with copper -811, also d 14. 180-205.
Beds 57, 58 and 59 may be compared with 77 ft. of "gray" melaphyre of Marvine's Section II. The recurrence of feldspathic melaphyres after a series of ophites is notable.

Feldspathic melaphyre (31) (40)

Amygdaloid d 9. 519-529
Upper 2 feet marked
Trap d 9. 529-550
More or less streaked with gray amygdaloid, feldspathic.
Cf. d 7. 811-834 more or less amygdaloid
d 14. 205-238 also feldspathic melaphyre
Horizontal drill hole 3 has from 29-115 beds tending to be glomeroporphyritic covering the suite 56, 57, 58 (14) + (9) + (31)
At 58 ft. a clay slip which also appears in the cross-cut is all there is to represent the top of 58. The top of 57 may be represented by a clay slip at 76 or prehnitic amygdaloid spots from 83-86. In the cross-cut this was the main belt of trap between the shaft and the conglomerate bed 54.

59. Melaphyre Baltic lode horizon (41)
Base below base of Mabb ophite direct 150
by adding 183
Amygdaloid d 9. 550-560
Trap d 9. 560-591
Cf. d 14. 238-282, copper at 264, mainly epidotic and amygdaloidal. Near 580 a clasolitic seam nearly parallel to the core making only a 20° angle with it is cut, and at 592 ft. there is a speck of copper. Near 591 it is brecciated and glomeroporphyritic, but there is no defined amygdaloid to the trap beneath, which may be a part of this.
Cf. d 3. 790-795, which also has a speck of copper as well as 834-845.
This is the belt in which the I. R. Sec. 12 shaft (Fig. 45) is sunk, and horizontal diamond drill hole 3 begins in it 209 or (164) ft. below the Mabb ophite, passing the amygdaloid at 20-29 ft. The west cross-cut remains in the lode for 30 ft.

60. Melaphyre (23)
Trap d 9. 591-614
Cf. the "21-foot amygdaloid" of Marvine's Section II.

61. Conglomerate (3) d 9. 614-685 (71)
Cf. Belts 31 to 33 and 43 to 45, also d 3. 879-891 d 14.282-353-373
A well-marked felsitic conglomerate, dip nearly at right angles (78°) to hole, at 628 ft. 2 ft. of sandstone with amygdaloid scoria, then nearly amygdaloid to 642, then sandstone and felsitic conglomerate with calcite cement passing into amygdaloid conglomerate at base, *very much like* Beds 32 to 34 and about the same thickness. Both have small amygdaloidal beds above, both have an ophite below but rather different in size, but while it is barely possible that there is a repetition by faulting, there can be no question that this is the Conglomerate numbered 3 by Marvine 1486 (1201) feet from No. 4. It is below the base of the Mabb ophite (685-451=234) ft. by addition 268
Hence below No. 4 967+234 (1201), and Marvine makes the thickness 70 ft.—a remarkably close agreement in both items.

Hence below the base of No. 6 (1201+552) (1753)
A corresponding distance at the Baltic location from No. 6? to the Baltic conglomerate is (1964) feet.
Cf. I. R. d 3. 879-891, which is largely a fluccan—a fault. This was also visible in the east cross-cut of Section 12 shaft, about 50 ft. beneath the shaft with a few boulders or residual nuggets of copper. It had a dip of 52°. The same faulting also disturbs Hole 10 so that its record is not worth anything as a consecutive records of beds. Hole 2 is perhaps a little better. Hole 2, 30-82 or to 106 matches this Belt 61, i. e., d 9. 614-685 quite well, having the same felsitic top, sandy streaks, amygdaloidal base and trap or amygdaloid intercalations.
Horizontal diamond drill hole No. 3 begins just above this conglomerate and runs 209 ft. up to the foot of the Mabb ophite, and can be correlated pretty well with No. 3 and the cross-section. In all these one bed occurs under the Mabb ophite that does not occur in 9.

62. Melaphyre (29)
Trap d 9. 685-690
A mere fragment of a sheet into which 62 has eroded?
d 2. 106-114
d 14. 373-398 (25) and perhaps also
d 14. 430-458
514-543
547-572

63. Ophite 2 mm. Cf. (42) (66)
Amygdaloid d 9. 690-694
Trap d 9. 694-749
At 698-703, 708, 723 ft. the grain
is 1, 1–2, 2 mm. From 733-749 ft. is finer.
Cf. d 14. 458-514, which is also a 2 mm. ophite
Basal amygdaloid ? 749-756
Brecciated, red and mixed, like a certain phase of the Houghton conglomerate.
Cf. Hole 2, 114-216, which has up to 2-5 mm. mottles, apparently equivalent to the bed at the end of the east cross-cut, e. g., at 210 ft. horizontally beneath the shaft. The sandstone and conglomerate at the end of d 9 from 756 on, that is 71 ft. below the main Baltic conglomerate does not appear in Holes 2 or 3 or the east cross-cut of the Sec. 12 shaft, or No. 14.
Along here the faulting makes a continuous record almost impossible. The shear zone seems in Hole d 14 and perhaps d 9, as also in the Superior trenches, to have spread the Baltic conglomerate, over a broad area as it seems to have spread the Mabb ophite in Hole 10.
Below this horizon of Conglomerate 3 the disturbance approaching the great fault zone which runs along the south border of the range is so great that though traversed by Holes 10, 2, 14 and exposed by trenches on the Isle Royale and Superior properties, no consecutive order of beds can be made out with any safety. The only thing to do is to give each record with occasional comparisons. Hole 2 seems as little disturbed as any of them.

64. Amygdaloid conglomerate. Cf. 45 (11)
d 2. 216-227
Brecciated and with white fragments on a red ground.

65. Ophite 2-3 mm. Cf. 46 (38)
Trap d 2. 227-265
Brecciated, mixed and decomposed brown trap'-244, at 245 the grain is 2-3 mm., and it is ophitic to 251, then to 265 finer grained and brecciated.

66. Melaphyre (36)
d 2. 274-281
Decomposed, full of calcite seams, fine grained at 308, spots of chloritic amygdules -310

67. (33)
Amygdaloid
Prehnitic at 310, poor to 325
Trap d 2. 325-343 (28)
Veined at 327-329, fine grained and red at the bottom.

Base below base of Conglomerate 3 343-106? (237)

68. Ophite (4 mm.)? Cf. (48) (Unfaulted about 100 feet thick?) (226?)
Amygdaloid d 2. 343-364
Trap d 2. 364-569
At 371, 387, 396, 413-423, 452, 470-510, 519, 541, 554-9, 567 feet the grain
is 1, 2, 1–2, 2, 3, 3, 4, 2, 1 , ½ mm.
At 408-413 and 452 there is much veining, and the thickness of the belt compared with the size of the mottling suggests that there is either much faulting or the dip has flattened very materially, the former being most probable, and if so it must be of the type that drops the lower or southeast side down or raises the northwest side for this would produce the unsystematic distribution of grain and exaggerated thickness of belt.

69. Ophite 1 mm.
Amygdaloid d 2. 569-580
Marked contact; the trap above has a red base, the amygdaloid is poor.
Trap d 2. 580-589
At 582 and 586 feet the grain
is ½ " 1 mm.

70. Ophite 1 mm. Cf. (50) d 3. 274-336 (30)
d 2. 589-619
At 609 ft. the grain is 1 mm.

71. Ophite. Cf. 51 (173)
Amygdaloid d 2. 619-621
Like that at 569 and probably the same thing, not lifted up quite so much.
Trap d 2. 621-792
Trappy; then at 627—amygdaloid and mixed ophite and amygdaloid, the latter marked at 630-633.
Veining frequent, e. g., at 690, 723, 733 ft.
At 706, 737, 755, 768, 778-784 feet the grain
is 4, 5, 2, 1–2, 1 mm.
This is evidently much disturbed and quite likely Belt 51 or some higher belt repeated, as is shown by the irregularity of the grain.

72. =52 ? the Mabb ophite 213+
Amygdaloid d 2. 792-822
Marked black and white
Trap d 2. 822-1005
Fine grained -827, at 837 amygdaloidal and ophitic—grain 2 mm., at 855 3-4 mm. but still amygdaloidal. Cf. the upper part of the Mabb ophite at d 9. 260
At 868, 889, 894–902, 955, 965–970, 1005 ft. the grain is
4, 5, 7, 8, 5, 8 mm.
This I believe is a repetition of the Mabb ophite, and we can correlate backward pretty well up to the Baltic conglomerate. So that there may be a big shear at about this point causing a repetition of the series. This may lie the same side of the fault as d 14. 572-813 which may also be a repetition of the Mabb ophite. Assuming this to be the case we should get a strike for the Mabb ophite on the S. E. side of the fault of N. 70° E, which is about the direction of the eastern sandstone contact.
The conglomerate d 14. 813-825 would then correspond to 54.
d 9. 451-453 and d 14. 131-141 or 172-3
d 14. 825-866 a feldspathic melaphyre would correspond to d 9. 453-471
d 14. 866-887 to 56 and 57, d 9. 471-510 and both have a glomeroporphyritic tendency
d 14. 887-904 } Brecciated and the breccia
d 14. 904-951 } would have to represent the interval to conglomerate
3 d 9. 510-614
d 14. 951-993 will be d 9. 614-685 a repetition of conglomerate 3.
d 14. 993-999 2 mm. ophite may be a fragment of 63, while the eastern or Jacobsville sandstone is apparently reached as a transition with no notable fault at 999, the transition being at 999 to 1001.
In other words d 14. 572-999 is a fairly solid block of repetition of the upper part of 14. But as we come into the bay made by the eastern sandstone in Section 12 if we are to fill it in this way we must suppose in Hole 2 that a still larger block has dropped or the same block been more spread out. As a matter of fact we find in Hole 2 good matches up to the very much faulted veined and disturbed and strung[1] out bed d 2. 343-569, at which point some of the faulting if not all may occur, but there are fair

[1]By stringing out I mean this: If a bed which should be cut at right angles by a hole plunging to the S. E. is sheared so that the N. W. side is lifted more than the S. E. side its apparent thickness along the drill core will be much greater and judging by the grain and other tests, abnormally great.

matches even above. The presumption is then that while the main axis of shearing is about at this point, there is some uplift clear up to the Section 12 shaft, in which there seem to be seams striking more easterly than the shaft and steeper. In Hole 14 the evidences of shearing are striking up to 358 ft. from 572 ft.

Isle Royale drill hole 10. Seems to show a few beds much strung out and disturbed by slip faulting. It is at an angle of 32° to S. 64° E. Elevation about 900 A. T. 1000 ft. W. 600 S. of the E ¼ post of 1-54-34.

(a 59?) Ophite, 2-3 mm. (37+)
Amygdaloid d 10. -54
Much shattered, all calcite and laumontite
d 10. 41-48, coarse to 54
Trap d 10. 54-77
At 57 the grain is 2-3 mm., then finer.

(b 58) (23)
Amygdaloid d 10. 77-87
Red to 82, greenish to 87
Amygdaloidal trap 87-99
Coarse pink and white feldspathic, with large amygdules.
Trap d 10. 99-100

(c 57) Amygdaloidal melaphyre (19)
Amygdaloid d 10. 100-119
Gray, coarsely amygdaloidal d 10. 100-108
More reddish d 10. 108-114
With 1 mm. phenocrysts of red plagioclase d 10. 114-119

(d 56) Amygdaloidal melaphyre
Laumontitic and irregular d 10. 119-133
Feldspathic with pinkish amygdules d 10. 133-151

(e 55) Reddish; more compact d 10. 151-155
Yellow-green epidote d 10. 155-159
Slips parallel to the core and about 26° to it are faulted by another set also at about 26° to it. The northerly displaces the westerly, assuming the slips parallel to the hole to be nearly vertical. The trap remains feldspathic, amygdaloidal and decomposed to 186 ft.

(f 54) Slip at 186 with banded clay at 56° to the core, that is vertical. This undoubtedly marks a considerable fault. The beds above remind one of those just beneath the Mabb ophite, while below there is a sudden jump to the middle of the heavy ophite with 5-7 mm. mottling. Other slips probably parallel to it and also vertical occur at 192-195 ft. and 225 ft.

(g 72 & 52)
Mabb ophite d 10. 186-663
At 186, 199, 203, 205, 213, 227 feet the grain
is 5–7, 8, 8, 5, 6, 3–5 mm.
which may well pass for a fragment of the Mabb ophite, then there are pink seams at 45° to 31° with the core. At 239-243 it is also full of clay slips at 22° with and parallel to the core, but these are very likely merely the result of shattering along the main displacement as the grain does not seem very much broken.

At 247, 256, 268 feet the grain
is 5–6, 5–8, 5 mm. and there are seams between 256 and 261 and at 268 ft. a heavy 3-ft. seam.

At d 10. 273 the grain is 3-4 mm., and at 277-280 it is seamed. At 282 the grain is 4-5 mm., and at 290 are seams; at 290-296 and 300 the augite grain is 7 mm., and 4 mm. with amygdaloid spots, reminding one of the top of the Mabb ophite. From 311-313 is a vein parallel to the core. At 316, 319-328 ft. the augite grain is 4-5 and 7? mm. respectively. There are joints at 19° and 45° to core, and about 365 a seam at 31°. At 374 the grain is 3-5 mm. At 378 is a seam parallel and at angles to the core. At 391 are amygdaloid specks. At 398 the augite grain is 7 mm. At 410 it is decomposed. At 412 the augite grain is 3-5 mm. At 416 it is much seamed both at 31° and 45° to the core and probably both vertical.

At 422, 430, 458, 462, 475, 498, 502, 514 ft. the grain
is 7, 5–8, ab.5, 5–7, 7, 5, 5, 3–5 mm. and there are seams at 430, most notably at 38° with the core, at 462 at about 39° with the core, and at 474 at 51° and at 494 both at 26° and 39°.

The effect of the faulting seems to keep the hole in about the same horizon. Beyond this I am inclined to think that the faulting gains and we are passing into higher horizons unless there is actual overturn.

At 526 and 531 it is specked and seamed with pseudoamygdaloid specks.

At 536 there is 1-2 mm. feldspar and amygdules.

At 538 the augite grain is 2-5 mm. A seam nearly perpendicular to the core, also fractures at 59° to it. Specked and amygdaloid to 571, about 575 the augite grain is 5 mm. But at 580-588 it becomes specked and more and more so and amygdaloidal and browner as though it were passing *up* into an amygdaloid slowly. The banding of the amygdules makes an angle of only 15°-20° with the core to 663. All along to 618 there are indications that the amygdaloid is being cut obliquely at 31° or so and that the hole is rising. The fact, too, that we remain in amygdaloid from 588-663 points to a very oblique crossing of the amygdaloid.

(h 51) Ophite (106)?
Trap d 10. 663-712
At 671, 675-678, 683, 691, 701, 706, 712 ft. the grain
is 1, 1-2, 2, 1, 1–2, 2, 3–4 mm.
Amygdaloid d 10. 769

Finely developed from 691 down, amygdaloid specks appear. This appears also to be cut in inverse order and obliquely. The grain would indicate only 100 ft. or so. Seams at 40° to core may be vertical.

(i 50?) Ophite d 10. 769-803
At 772, 787-790 the grain
is 0.5, 1 mm.

At 783 the seam at 31° is faulted by others and at 796-803 are heavy veins nearly parallel to the core.

If inverse order continues these might perfectly well be Beds 51 and 50 respectively.

Isle Royale drill hole 13. Near (340 ft. W. 280 ft. N. of it) the S. ¼ post of Sec. 11, T. 54 N., R. 34 W. At an angle of 45° to the S. E., *about* at right angles to the strike. The projection crosses the line 116 ft. W. of the ¼ post. Elevation 375 above Lake Superior. It is probably so near at right angles to the strike that no correction is necessary.

1. Drift. Till full of boulders. 85 (60)
2. Ophite 58+
   Trap d 13. 85 to 153
   At top with spots of white amygdules with a green and red base or gray feldspar laths on a red base, and chloritic amygdules.
   At 117 to 134 and 143 a 2 to 3 mm. respectively 2 mm. ophitic mottling.
3. Ophite 81 (81)?
   Amygdaloid d 13. 153 to 159
   Trap d 13. 159 to 234
   At 175–9, 191, 209, 222, 234 feet the mottles are
   1, 2, 5?, 1, 0 mm. respectively
   Along about 209 are many calcite seams, some at 59° to the core, which may be near vertical, and be faults disturbing the grain which soon often grows finer.
4. Ophite 118 (118)
   Amygdaloid d 13. 235 to 239
   Trap d 13. 239 to 353
   At 253, 270, 283, 310 (center? finer below), 337, 353 the mottles are 2, 2–3, 3, 5, 2, 0 mm.
5. Melaphyre (feldspathic?) 44 (44)
   Amygdaloid d 13. 353-357
   Trap d 13. 357-361
   Amygdaloid d 13. 361-365
   Trap d 13. 365-397
   Specked from d 13. 383-397
6. Fault breccia (or conglomerate?) 397-400
   This is an obscure bed, very red and brecciated, and may not be a conglomerate, merely a fault breccia. If it is a conglomerate the grain below shows that it must rest on an eroded land surface. But is probable that in any case there is a big slip here as half the bed below is absent.

[52]. 7. The Mabb ophite. 113+ top removed (230?)
   Trap d 13. 400-513
   Begins coarsest; at 405, 433, 472, 499 ft. the mottles
   are 8, 5, 3, 1–0 mm. respectively.
   It is much veined and seamed; one set nearly parallel to core, probably vertical or nearly so, striking S. E.; another nearly at right angles, at an angle of 71.5° with core, 63.5° with vertical perhaps. If this is the Mabb ophite it is the bed at the top of Hole 14 and occurs quite persistently a short distance above the horizon of the Baltic Lode.

   In Holes 14, 13 and 3 the normal rate of increase of augite grains A appears to be for the Mabb ophite respectively 1 mm. in 13.8, 13.2, and 15.8 feet.

8. Ophite 27 (27)
Amygdaloid d 13. 513-519
Not marked but fine grained to 527
Trap d 13. 519-540
At 527 to 534 faintly ophitic, with two sets of pink laumontitic fissures at right angles to each other and at 33°⅔ and 56°⅓ to the core.

9. Ophite 44 (44)
Amygdaloid d 13. 540-548
Veined; coarse; epidotic.
Trap d 13. 548-584
2 mm. mottles at 565 ft. Seams are at only 10°-15° angle with core.

10. Feldspathic melaphyre 42 (42)
Amygdaloid d 13. 584-595
Light gray-green amygdaloidal
Trap d 13. 595-626
This is slightly coarser; 1 mm? at 605 feet, and glomeroporphyritic with feldspar aggregates. Towards the base there is a sandy clasolitic seam nearly at right angles (79°) to the core.
In Hole 14. 132 to 282 we seem to have under the heavy ophite a group of somewhat similar extra feldspathic traps.
The suggestion seems plausible that in d 13 the Mabb ophite has not been as much upheaved as in d 14; in the former case the big slip is above, in the latter below 14.

11. Feldspathic melaphyre 34 (34)
Amygdaloid d 13. 625 to 635
Trap d 13. 635 to 660
Specked at top and somewhat porphyritic with feldspar.

12. Feldspathic melaphyre 14 (14)
Amygdaloid d 13. 660 to 674
The bottom contact of this is marked, as often happens with the feldspathic beds, the tops are ill marked and they are more or less amygdaloidal throughout. It is quite likely that 10, 11 and 12 are all one flow. In Hole 14 we find similar beds between 14. 131 and 14. 282, and in Hole 3 beneath the heavy ophites down to 3. 673 there is a considerable interval down to 3. 891 in which no marked ophites occur. This hole seems on the whole less disturbed at this point than the others.

13. Amygdaloidal melaphyre d 13. 674 to 694
The amygdaloid is marked and seems to dip at an angle of 51.5° against the core, but this may be the effect of numerous slips at 45° to the core, probably vertical seams which seem to attend the big fissure.

14. Fissure
Extensive shearing at 45° to the core, i. e., probably about vertical.

15. Feldspathic ophite. Baltic lode and Foot?
Amygdaloid d 13. 696-698
Trap d 13. 698-744 or 748
At 701 to 704 a little copper
Dr. Hubbard's thin section at 705 ft. shows under microscope a coarser ground mass than d 3. 872 of about half plagioclase laths; about a tenth iron oxides, idiomorphic but largely secondary, minute specks of disseminated calcite, and some filling very minute cracks, apparently not over 5%, and a few porphyritic feldspar crystals?
At 725 ft. it remains speckled and slightly porphyritic in appearance. At 731 to 4 there appears to be a faint 2 mm. mottling. At 737 it is so brecciated as to look like a conglomerate, and continues gray brecciated to 748. But this is probably not a genuine conglomerate. Conglomerate 3 may be thrown back by the fissure of Belt 4.
This may probably be continued by the section of the trenching on the east side of the N. E. ¼ of the N. W. ¼ of Sec. 14, T. 54 N., R. 34 W. which begins at the S. E. with holes in the eastern sandstone and exposed a good deal of disturbed matter and at least one fairly heavy ophite and four amygdaloid zones in some 300 or 400 ft. A black and white amygdaloid with copper float may be in the lode near which No. 13 ends.

Isle Royale drill hole 14. About 1100 ft. E. and 300 ft. N. of the S. ¼ post of Sec. 11, T. 54 N., R. 34 W. Elevation 386 A. T. Put down *about* at right angles to the strike and dip at an angle of 34°. In the pit in which it was started the overburden was in places not 5 ft. deep. It is paralleled by trenching from the S. E. corner of the S. W. of the S. E. of Sec. 11.

1. Drift 30 ft. (17)

[52]. 2. The Mabb ophite
Trap d 14. 30-131 + 101 + top equal (203 + ?)
This coarse ophite seems to be about the same in grain as that d 14. 600 to 700, which *may* be the same dropped down, or rather not thrown up so much, and appears to be the one found almost continuously, shortly above the horizon in which the Baltic lode is sought. At 76 is an amygdaloid or doleritic spots; at 115 numerous chloritic slips at 22° to the core; at 131 slips parallel and at 22° to the core, and also a white seam at less than 22° is faulted by one at 23°. This could be explained as a vertical seam striking N. thrown by a northwesterly seam with a rather flat hade to the N. There are others parallel and at 53° to it,—the latter probably nearly parallel to the dip. The grain shows at
30, 41, 62, 84 (finer), 99, 115, 127 feet ophitic mottles respectively
8, 5–7, 4–5, 5 3–4, 2–3, 1 mm. across
an average rate of increase of about 1 mm. in 13 ft.
Cf. I. R. d 3 from 673 back to 565 ft.

3. Brecciated amygdaloid and very likely slide or a little amygdaloid conglomerate d 14. 131-141 10 (10)
The breccia shades into the underlying trap, but there appears to be red and dark green fragments of sedimentary origin, epidote and calcite, in the amygdaloid.

4. Feldspathic ophite 31 (31)
Amygdaloid removed or included in the overlying bed.
Trap d 14. 141-172.
Specked, fine grained, slightly porphyritic to 151. At 152 a cal-

cite seam at 68° to the core; at 152 seams parallel and at 45° to the core; at 162 ophite 2-3 mm. mottles; at 168 1-2 mm.

In this hole there is *very little* of the feldspathic beds under the Mabb ophite prominent in No. 13. It may be that they are faulted out in Bed 3 and so the sedimentaries of the Conglomerate 3 group brought nearer.

5. Basic sandstone and conglomerate d 14. 172-180+ 8 (8+)

Well-marked at 172; at 173 pebble of black and white amygdaloid in it. A seam at 35° to the core is faulted by one perpendicular to it but parallel to the core. The bed passes at 180 into epidotic conglomeritic appearing stuff.

Cf. I. R. 3. 706 to 722.

6. Ophite 25 (25+)

Amygdaloid eroded away or merged in the seam above

Trap d 14. 180-205

Fine grained with occasional laumontite seams, reaching 1 to 2 mm. mottles at 192 ft. with seams at 31° and 53.5° against core.

7. Feldspathic melaphyre 33 (33)

Amygdaloid d 14. 205-212

Seamed at 22° to the core; epidotic at the base.

Trap d 14. 212-238

Fine grained, feldspathic looking, with seams at 11° against the core.

8. Feldspathic melaphyre Baltic lode? 44 (44)

Amygdaloid d 14. 238-249

Poor

Amygdaloidal trap d 14. 249-282

While the amygdaloid as a whole is poor looking, yet at 264 there is a prehnitic alteration of the slightly glomeroporphyritic feldspathic trap which carries a trace of copper. The seams are at 22.5° against the core. This is in feldspathic beds like d 13. 701, and is near the second amygdaloid below d 14. 172 to 180 which we have matched with I. R. d 3. 706 to 722. In No. 3 the second amygdaloid is at d 3. 790-795 which has also a little copper with which we may correlate it provisionally. This, too, is the belt upon which Section 12 shaft is sunk. It seems to bear a little copper quite persistently. It is the second amygdaloid above the first conglomerate below the Mabb ophite. This brings it about the position of the Baltic lode.

9. Amygdaloid conglomerate d 14. 282-310 28+ (28)

The sediment contact is about perpendicular to core, at 71° with it, and there are seams 31° with the core. At about 288 it changes to a decomposed bed, apparently an amygdaloid conglomerate which remains the same to 310, after which there is a good deal of trap, perhaps merely a talus block.

10. Trap? d 14. 310-328 18 (18)

Fine grained, perhaps a talus block.

11. Conglomerate d 14. 328-353+? 25 (25)

This is a clear, well-marked conglomerate, with quartz grains (333) and occasional pebbles. The dip makes an angle of 31° with the core; at 336 is a regular clay (red fluccan) and there is a mixture of trap and conglomerate with very abundant seams of red clay

which make an angle of about 49° with the core, to 348; thence to 353 is mainly conglomerate.

12? Trap d 14. 353-358 5 (5?)

At 358 is a slip parallel to the seam and another at 49° to it. It is a question whether this is a block in the conglomerate or faulted in. It is certainly not a normal succession as there are no amygdaloids and it is thin.

13. Conglomerate d 14. 358-373 15 (15)

Well-marked and with small apparently felsitic pebbles; seams at 79° to the core; the basal contact is well marked. It is probable that Belts 9 to 13 are closely allied making up the general horizon of Conglomerate No. 3,—the Baltic Conglomerate. But in such case compared with the section at Baltic a good deal has been cut out. The general position corresponds to No. 3. 879 to 891 where, however, the red fluccan represents a hiatus. No. 13 *may* be just approaching this horizon at the very bottom 738 to 747. It is near the top of I. R. d 2 where 55 to 106 corresponds roughly to d 14. 328 to 373. This is a good deal nearer to the lode I have called the Baltic lode than the Conglomerate is at the Baltic. But it must be remembered that at the Champion it is still farther away than it is at the Baltic.

14. Melaphyre 25 (25)

Amygdaloid d 14. 373-380

Marked; seamed parallel, and at 45° to the core.

Trap d 14. 380-398

Fine grained; seamed parallel, at 11° and 45° to core.

Amygdaloid d 14. 398-400 2 (2)

Red base, white amygdules dip 49°; seams at 18° to core; bedding at 71.5°; faulted by seams at 11° to the core.

15. Conglomerate d 14. 400-430? 30 (30)

At 407-409 trap black; then felsitic to 420; at 424-430 more trap; at 430 a brown rock with blotches which I take to be derived from a steam filled mud.

16. Melaphyre? 23 (23)

Amygdaloid d 14. 430-436

Trap d 14. 436-453

Brecciated until it looks like conglomerate at 443, then hard and seamed (at 53° to 48° against core).

17. Melaphyre 5? (5)

Amygdaloid d 14. 453-456

Trap d 14. 456-458

18. Ophite 56+ (60)

Amygdaloid d 14. 458-462

Amygdaloidal melaphyre d 14. 462-466

Amygdaloid d 14. 466-470

Well-marked gray and white and red.

Trap d 14. 470-514+

Seamed at 68° and 34°

The ophitic mottles are rather separate, like scattered rice grains; at 483, 497, 507 to 511 the mottles are 1-2, 2, 1 to 2 mm. respectively.

Then at 514 there is a big seam and then coarser mottling.

Evidently about 10 ft. of the base of this flow is cut off as well as the top of the next.

19. Ophite 29 (40+)
Amygdaloid (cut off by big fault)
Trap d 14. 514-543
At 520, 530 growing finer
2–3, 2 mm.
This is much seamed near 514; again at 520 at 90° and 64° with core.
This is quite possibly a repetition by faulting of the lower part of 18.

20. Breccia or conglomerate replacing amygdaloid
d 14. 543-547 4 (4)

21. Ophite 25 (30±)
Trap shattered d 14. 547-572
Brecciated at 550-555 and quite like a conglomerate in place to 569. Still veined and brecciated to 572 where it is very much seamed. Ophitic mottles in spots, at 549 1 to 2 mm.

22. Probably large fault repeating the series near 572 0 0

23. Ophite (the Mabb ophite repeated?) d 14. 572-813 241 (250)
This ophite is much seamed and veined and the grain more or less irregular, but on the whole it appears as coarse as the Mabb ophite toward the center, by direct comparison. It has a redder hue due to alteration, and the patches of mottles seem more isolated, which may be due to a more extensive chloritization of the augite patches before they were oxidized. It *may* of course be some other large ophite. The mottles are:
at 578, 581, 588, 598, (seamed and faint from 604 on), 627,
1, 2–3, 3–5, 5+, 5–7,
649, 668, 750, 760-783, 801 feet.
5, 5-7, 1, fine, seam, 2 mm. across.
The slips make with the core an angle of 51°, etc., 74°, 60°, 35°, 31° being probably near vertical; at 588, 637, 647, 742, 783 respectively; from 604 to 627 full of red seams and brecciation; and to 660 much seamed, and especially just above 742, and about 783 feet.

24. Conglomerate d 14. 813 to 825 12 (12)
Marked, felsitic.

25. Felsitic melaphyre 41 (41)
Amygdaloidal trap d 14. 825-827
Trap d 14. 827-866
Begins black and white amygdaloid, grows gray and coarser with less amygdaloid, grows finer from 859 down.

26. Felsitic melaphyre 21 (21)
Amygdaloid d 14. 866-875
Marked; dark base with gray and pink laumontite
Trap d 14. 875-887
Bunches slightly glomeroporphyritic with 2 mm. bunches of feldspar.
These beds seem to come under the Mabb ophite in Hole 13.

27. Melaphyre 17 (17)
Amygdaloid d 14. 887 to 891
Heavy calcite seam at base
Trap d 14. 891 to 904
Speckled and at base brecciated and perhaps conglomerate.

28. Breccia or conglomerate d 14. 904-951 (47±)
Looks especially conglomeritic about 914; speckled and faulted to 922; conglomerate? to 924; ophite pebbles 3 mm.; at 932 2 mm.; at 934 1 mm., and finer, full of seams, to 944 and brecciated beyond. On the whole this appears like a shattered ophite and we get spots showing 2 mm. mottles; at 949 mainly seamed; at 951 seems to be a little regular conglomerate.

29. Amygdaloid conglomerate with streaks or blocks of trap and amygdaloid d 14. 951-993 42 (42)
Amygdaloid d 14. 951-955
Trap d 14. 959-963; 969 to 971; 983 to 987.
These small streaks are either faulted in or are blocks.
Ophite d 14. 993-999 6±
The mottles are 2 mm., showing that this is a block.
From 999 to 1001 is a transition to the Eastern sandstone.

30. Eastern or Jacobsville sandstone d 14 999-1017
Dip about 45° with core from 999 to 1001; to 1004 coarse grained, mainly white, rounded quartz with few dark red or black grains also; dip against core 59°, 49° or 45°.

The Isle Royale did some work on Section 12, farther southeast along the strike, the results of which are given in Figure 45 and shown in Plate X and discussed somewhat above. I conceive that near the eastern sandstone some blocks containing the Mabb ophite have not been so much unheaved, so that we are liable to find that and the underlying Baltic horizon repeated. It is, of course, possible that faulting has brought together other similarly heavy ophites. It is also probable that the smooth and continuous curve in which Conglomerate 8 was put in on Plate X, connected by dots that show our ignorance, will be found to be broken here and there, and that these breaks become more and more pronounced near the great fault.

It will be seen from the Isle Royale cross-section (Fig. 44) that I consider the formation much distorted and sheared at the south end. In other words, I believe that as we approach the south side of the range, which is bordered by a fault that aggregates many thousand feet, we meet more and more numerous disturbances. Is there not evidence that motion in this plane took place at various times during a long interval, that the Lowest Keweenawan (the Bohemian Range group) was upheaved long before the nearly flat Freda sandstones were laid down,—indeed, before the Calumet and other felsitic conglomerates which contain pebbles of its acid intrusives? But there seems also reason to believe from the disturbed condition of Limestone Mountain, so carefully worked out by W. L. Honhold, (Fig. 47) that disturbances occurred along this line even after the Niagara, perhaps at the time of the Appalachian

revolution. Thus it is perfectly possible to find wedges of Jacobsville sandstone, as shown in the Torch Lake section, formed on the Keweenawan and at the same time overlapped by it in this later faulting.

§15. FAULTING NEAR PORTAGE LAKE (PL. X.)

The valley of Portage Lake is not itself due to faulting. It was rather carved down into the Trap range by some superimposed river which flowed across flat lying sedimentaries from the Huron Mountain boss, while gradually erosion exposed the Trap range. This implies that the Trap range, as we now have it, was once completely enveloped with sandstone or other flat lying sedimentaries, and that the lowlands of sandstone on either flank are the result of erosion. Cores and blocks of sandstone high up on the range, residues clinging to it like those which have been described by Hubbard,[1] and the sandstones and the sedimentary Trenton and Niagara limestones of Limestone Mountain both confirm this view. But Marvine describes a fault as following Portage Lake which would, on passing from the north to the south side, heave the Allouez conglomerate 710 feet[2] horizontally, at right angles to the strike, and other beds from 705 to 740 feet. Recent work at the Dacotah (South Quincy) confirms this. On the other hand, Hubbard and W. W. Stockly had made a very careful survey of the Isle Royale-Arcadian lode and as a result[3] came to the conclusion, which I think a comparison of the detailed drill section here given only confirms, that the Isle Royale and Arcadian bed were the same and that the horizonal displacement could at most be 275 feet, and that a gentle curve of only 3° 20′ in 15,000 feet would make them continuous. Now to reconcile these facts we may suppose (1) a fault of increasing throw along the lake, (2) a strike fault with a dip other than that of the beds stopping or changing the amount of displacement suddenly at a fissure near the lake, (3) a fault which as Conglomerate 8 can be followed south of Portage Lake quite continuously through Sections 1 and 36, and the Isle Royale mine levels run from Section 1 through 36 to 11, would have to run north.

There are disturbances in the Hancock mine, and the Quincy cross-cut described above has the Allouez conglomerate (15) replaced by a slide with an average steep dip of 63°, while the conglomerate which might be identified with the Houghton might also

[1]Vol. VI, Pt. II, pp. 123-124. See also map of Sec. 12, T. 54 N., R. 34 W.
[2]Vol. I, Pt. 2, p. 61.
[3]Vol. VI, Pt. II, pp. 108-109.

be the Allouez faulted back. But this would seem to be negatived by the continuity of the mine drifts unless there has been an unconscious passage from one amygdaloid horizon to another. As C. D. Lawton says in his reports as Commissioner of Mineral Statistics, the Quincy mines a belt 200 feet wide including more than one amygdaloid.

The developments in the Hancock mine in which considerable displacements may be expected will in time settle the question definitely. The Quincy mine has an apparently tight calcite parting, shown in the published mine maps, which runs from near No. 25 shaft about N. 35° W. Near this and near fissures generally the vein is leaner. The Quincy is, on the whole, one of those "richest under high ground." There seems also to be a slide from No. 7 running more nearly east and west and dipping to the north. Whether there is a block dropped between these two back to the southeast may be a question. It is often reported to be leaner with depth and in No. 8 shaft at the north there was, at least at the beginning, more laumontite, less prehnite.

Supplementing Section XI of Volume I of these reports, we may add the following notes. The Freda sandstone is exposed not only there along the Lake Superior shore but on the hill in Section 29, T. 54 N. and R. 34 W., and it is said also in Boston Creek, Section 2 of the same town and in St. John's Creek a mile northeast. It is also found in Cole's Creek, Section 33, where it dips 12° to N. 67° W. As such dips are within the range of initial deposition dips, it is very unsafe to estimate thickness from them. There is a breadth of over seven miles which at a 12° dip would give a thickness (6,300 feet).

Then to the Atlantic stamp mill the dip probably steepens to match that on the north side,[1] for in the creek valley the sandstone dips 28° to 29° to N. 70° W. It is broken by small slips and displacements parallel to the trend of the Trap range which is more east of north. One *might* add a thickness of 4,400 x sin 28° (2,100 feet).

File 14-4 is an old section by E. J. Hurlburt, (July, 1858), of the section along the south shore of Portage Lake duplicating XI of Volume I to some extent. The distances are scaled along an east and west line. To get thickness one should multiply by (cos 33° x cos dip) or about .3. From the sandstone just mentioned to the beginning of this old section is about 1,700 feet in thickness, (800) to (1,000) feet. The numbers to the conglomerates are those of Marvine's Section 11.

[1]Which dips 24° to 29° to N. 63° 23′ W. L. L. H.

22.	"Conglomerate extent undetermined 1200 feet to west boundary"	80+		
	"Compact gray trap"	86	(26)	
21.	"Old red sandstone"	20	(6)	
	"Amygdaloid"	68	(21)	
20.	"Vein split up laumontite strings. 25 lb. copper taken out, ancient pits, stone implements on this vein and charcoal found, 1858	24	(7)	
	"Coarse gray trap granular"	132	(44)	
19.	"Old red sandstone"	18	(6)	84
	"Trap gray compact containing a heavy deposit of epidote"	126	38	
	On hanging of conglomerate "large vein epidote, spar, prehnite, and some quartz. 100 lb. copper taken out, ancient pits on this vein," June 25, 1858.			
18.	"Conglomerate"	200	60	98
	"Small vein spar, epidote, laumontite" "Strings of laumontite" "Coarse gray trap". "Epidote vein"	350	(105)	
	"Gray compact trap resembling the overlying of rock of Pewabic lode	350	(105)	

Next is about 620 feet from the quarter post just mentioned covered by the trenching of cross-section and including Conglomerate 17, the Hancock West. This takes us to a hole put down by the Dacotah Heights Company. This was at 45° to S. 56° W., practically at right angles to the strike, and so nearly at right angles to the dip that less than 4% correction certainly is necessary. It is 36 feet A. L. S. in the mouth of an old adit from which there is a stream. The record by A. H. Meuche follows and begins nearly where cross-section XI ends.

Dacotah Heights drill hole 1.

1. Glomeroporphyritic ophite.
   No. core d 1. 0-15.
   Trap d 1. 15-87.
   The hole started above an old trench and is in foot wall of lode when they began to drill. The first fifteen feet for which there is no core probably represents the amygdaloid upon which they were trenching.
2. Glomeroporphyrite.
   Amygdaloid with copper d 1. 87 -94
   Trap (Porphyrite) d 1. 94 -97½
   Amygdaloid with some sediment d 1. 97½-98½
   Trap d 1. 98½-108.
   These two beds have the characteristics of the beds immediately above the Pewabic lode. The feldspar crystals have aggregated into groups presenting to the eye a sort of mottled appearance somewhat like the ophitic mottlings except that they are not so pronounced and are whiter in color. If well pronounced these aggregates are liable to be mistaken for amygdules. These same beds are often porphyritic and individual feldspar crystals larger than the general run of them are found not only in these cores but in specimens from other places.

3. Glomeroporphyrite.
   Amygdaloid d 1. 108-114
   Trap 114-116
   Amygdaloid 116-121
   Trap 121-126
   Beds Nos. 2 and 3 seem to be united north of Portage Lake.
4. Glomeroporphyrite.
   Amygdaloid 125-132
   Trap 132-140
   Amygdaloid (or bomb?) 140-142
   Trap 142-164
5. Glomeroporphyrite.
   Amygdaloid d 1. 164-167
   Trap d 1. 167-183
6. Glomeroporphyritic ophite. Pewabic lode and Foot.
   Amygdaloid d 1. 183 -189½
   Trap 189½-193
   Amygdaloid 193 -197
   Trap 197 -296
   The top of this flow is the Pewabic lode and is probably represented by these two amygdaloids with the intervening trap.

   Base of flow above base of Allouez Conglomerate (394)
   North of Portage Lake this distance is (379)
7. Glomeroporphyritic ophite. Old Pewabic lode and foot wall.
   Amygdaloid d 1. 296-306
   Trap 306-332
   Amygdaloid 332-336
   Trap 336-339
   Amygdaloid 339-345
   Trap d 1. 345-347
   Amygdaloid 347-350
   Trap 350-406

   Base above base of Allouez conglomerate (284)
   North of Portage Lake this is (278)
8. Ophite
   Amygdaloid d 1. 406-442
   Trap d 1. 442-526
   This is more typically ophitic than any of the beds above. The mottlings are here caused by the augite crystals. The bed is thicker here than to the north and causes somewhat of a discrepancy.

   Base above base of Allouez conglomerate (164)
   North of Portage Lake this is (249)
9. Glomeroporphyrite. Albany & Boston Amygdaloid and Foot.
   Amygdaloid d 1. 526-530
   Trap d 1. 530-567

10. Melaphyre
    Amygdaloid d 1. 567-581
    Trap 581-602
    Amygdaloid 602-605
    Trap 605-628
    Amygdaloid 628-629
11. The Mesnard lode.
    Sediment d 1. 629-631
    Often called the St. Mary's lode or Epidote and Mesnard Epidote. An indurated volcanic ash. Around Portage Lake is epidotized and it, together with the Allouez conglomerate beneath, make one of the easiest and surest correlations which we have in the entire Keweenawan Series.

    Base above base of Allouez conglomerate (59)
    North of Portage Lake this is (90)
12. Glomeroporphyrite.
    Amygdaloid d 1. 631-635
    Trap d 1. 635-642
13. Ophite (?). "The Greenstone."
    A series of traps and amygdaloids d 1. 642-674.
    This is all that is left of that bed so famous and strong in Keweenaw County.
14. Allouez conglomerate
    Conglomerate d 1. 674-690
    Often called the Albany and Boston conglomerate. It often carries copper but in no place so far has there been enough copper to pay to mine. According to Marvine this is Conglomerate No. 15.
15. Ophite 4 mm.
    Amygdaloid d 1. 690-696
    Trap 696-700
    Amygdaloid 700-712
    Trap 712-714
    Amygdaloid 714-720
    Trap 720-725
    Amygdaloid 725-730
    Trap 730-734
    Amygdaloid 734-737
    Trap 737-795
    I speak of this as a four mm. ophite because the mottlings reach a diameter of four millimeters. The size of grain of these ophites is often useful in correlating.
16. Feldspathic ophite. 4 mm.
    Amygdaloid d 1. 795-806
    Trap d 1. 806-863
    This amygdaloid may be correlated as the Medora lode but the distance between the two points is too great to consider this as anything but a suggestion.
17. Ophite 6 mm.
    Amygdaloid d 1. 863-867
    Trap d 1. 867-982
    If the above correlation is allowed this ophite could be called the Mandan ophite. North of Portage Lake the amygdaloidal top to this bed has been called the "Ragged Amygdaloid" by Marvine. M. G. S. Vol. I.

18. Feldspathic Trap.
    Amygdaloid d 1. 982-989
    Trap d 1. 989-1007
19. Ophite.
    Amygdaloid d 1. 1007-1017
    Epidotic Sediment d 1. 1017-1020
    Trap 1020-1060

It will be noticed that Meuche, and I think he is right, places the Allouez at 690 feet which would correspond to about 250 feet horizontally across the strike, and would bring it nearly in line with what *has* been called the Houghton conglomerate in the Quincy adit. The Mesnard at 630 would be thrown 790 feet over. The Pewabic lode at 189 would be thrown 235 feet over.

§16. ATLANTIC (PL. X AND FIGS. 46 AND 47.)[1]

The collapse of the shaft on the old Atlantic lode some time ago has caused them to give considerable attention to explorations, both in their land on Section 9 and Section 16, T. 54 N., R. 34 W. In Section 9 continuous trenching was carried out (as shown on Plate X and Figure 46) with special eye to the Quincy lodes.

At 483 feet a conglomerate has been struck in two places, Hubbard's Conglomerate B.

At 830 feet from the Atlantic foot was a heavy trap. Cf. Tamarack 5 belt 20.

At 849 Amygdaloid for a few feet.

At 865 was near the center of the next trap, the rock at 879 feet was like Sp. 16413 close above Conglomerate 16.

At 879-890 was an amygdaloid with copper (one of the Hancock lodes?)

At 913 was trap. Cf. Sp. 15304.

At 935 was amygdaloid of the Ashbed type.

At 963 was a trap, a porphyrite of the Ashbed type.

At 997 was an amygdaloid with copper. I take it that the next 200 feet are the horizon of the Quincy mine.

At 1012 was a slightly sedimentary top of a flow which extends to 1040. Cf. Tamarack 4b 28 and Sp. 16428 and 16429.

At 1040 to 1085 A there was amygdaloidal porphyrite. Cf. Sp. 15351.

At 1115-1133 was a marked basal trap.

At 1133-1161 was a coarse amygdaloid like some of that at the Quincy.

At 1161-1179 was trap, coarse, massive, feldspathic and chloritic, like that which occurs around the Quincy mine, cf. 16416 A.

At 1179-1194 was amygdaloid. Then trap, at 1225 coarsely feldspathic and chloritic.

At 1232-1234 was two feet of amygdaloid. Cf. Sp. 16413. Then trap of the ashbed type still, oligoclase porphyrite. Then a coarse, doleritic trap.

At 1465-1482 is amygdaloid. (Cf. in the Franklin Junior the heavy amygdaloid belt 100 to 150 feet above the Mesnard). Then another trap.

At 1605 is, I think, the Mesnard epidote, a few feet shading into amygdaloid. Just underneath is a well-marked ophite, not very thick, the first marked ophite and so, I think, the last edge of the "Greenstone" to 1650.

From 1650 to 1675 is a conglomerate which would then be the Allouez (No. 15).

At about 1850 is an amygdaloid with below it a well-marked ophite with 3 to 5 mm. mottles. (Cf. the Mandan ophite.)

[1]Plate X and Fig. 47 are in envelope. The Atlantic Mine is now consolidated with the "Copper Range" companies.

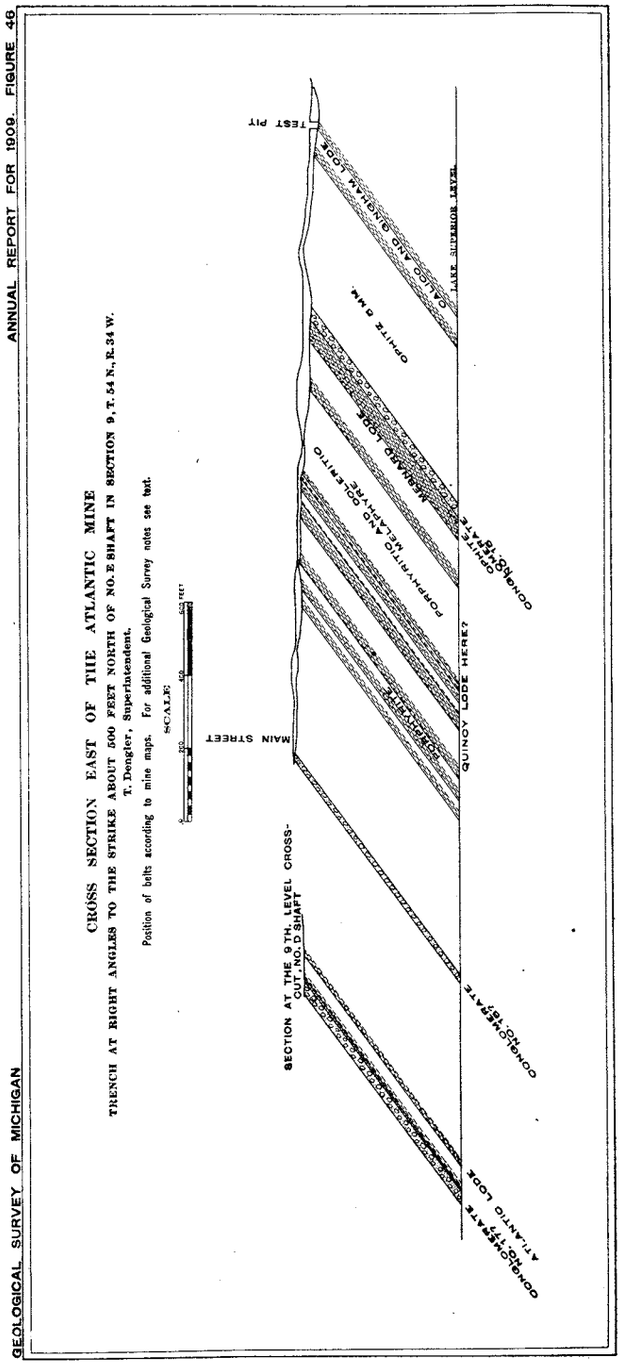

Fig. 46. Atlantic mining explorations on Section 9, T. 54, R. 34.

From 2200 to 2250 are brilliantly colored brecciated red and green (epidote) and white (calcite) amygdaloids or amygdaloid conglomerates, so-called "calico" lodes, much like stuff that commonly occurs near the horizon of the Houghton conglomerate and Montreal lodes. The character of the associated traps (not known to Hubbard when he wrote Volume VI) leads me to be pretty sure that the conglomerate at 1650 feet is the Allouez, No. 15. The Mesnard is also a characteristic bed. The one at 483 feet would, then, be about (1000) feet in thickness above it, and Conglomerate A, close above the mine, (the splitting off of a great block of the hanging wall along this conglomerate closed up the mine) is (468) higher yet, and the three will be 15, 16 and 17, a correlation to which Hubbard calls attention in a foot note.

It is clear that the beds of Section IX of Volume I and those exposed on the Dacotah property near where the Copper Range crosses the Highway are above the "Mesnard Epidote" and are in the Ashbed group and not far from the beds mined in the Quincy mine. Swinging them in as indicated on Plate X would necessitate a fault of not over 300 feet.

About 2000 feet from this Houghton (?) conglomerate at the end of Section 9 trench would pass a strike line connecting a marked conglomerate on Section 2 with one (dip 55° to 60° to N. 32° W.) about 1300 paces north, 300 west of the northeast quarter of Section 17. The associated rocks are similar to rocks southwest from it near the foot of Wheal Kate, beautifully skeined and banded with amygdaloid seams, rather feldspathic, with a dip of 60°-70° to N. 38° W., say (2560) feet from or (2100) feet below what I take to be the Allouez as against (1942) for the Kearsarge-North Star at the Arcadian.

About 200 paces south begins the S. Range drilling (Fig. 47) and while Hole No. 4 (the southernmost) cuts Conglomerate 8 to 6, the others do not, so that we may feel confident that this conglomerate is either 9 or the group 10 to 12, the Kearsarge. Farther south at the Winona we found a number of sedimentary beds at about this horizon. I think, therefore, we may safely call it the Kearsarge as that is stronger and more of a felsitic conglomerate, and less of a sandstone than No. 9.

The Kearsarge lode and Wolverine sandstone horizon is then untested. The rest of the section to the Atlantic cross-cut on Section 16 is covered by the South Range holes. The following are the engineer's notes of location. (See map).

From this conglomerate hanging it is 5626.87 feet to the Baltic 0, and 5767 feet from the hanging of Conglomerate 3 which is 97.56 feet from the Baltic 0.

No. 5, South Range is 5368.49 feet from Baltic outcrop and lode. Elevation 529.3 A. L. S. Dip 44° 41′

No. 3 4458.51 N. W. of Baltic 0	El. 418.7 A. L. S.	Dip 45° 11′
No. 1 3581.38 N. W. of Baltic 0	513.1	Dip 46° 26′
No. 2 3546.02 N. W. of Baltic 0		Dip 60°
No. 4 2858.44 N. W. of Baltic 0		Dip 46° 24′

The detailed records have been used in constructing Fig. 47. (It will be noticed that with a dip of hole of 46° and a dip of strata of 68° the distances along the hole and horizontal will be the same).

The ground intervening is 3 and 10 is drift covered and does not belong to the Atlantic Mining Company, so that they take up the section again in Section 16. Unfortunately their work there is so close to a cross-fault that it is seriously disturbed and down to the 21st level they did not find the lode valuable or settled. (See Plate X).

The South Range is the only section I know of that is complete above Conglomerate 8, but below there are a number. There is a mass of notes on trenches on Isle Royale and Superior, but they show more or less faulting and are disturbed

and incomplete. Underground we have the Atlantic Section 16 cross-cut, Fig. 47 notes of which follow.

Atlantic mine cross-cut (Fig. 47 and Pl. X) Section 16, T. 54 N., R. 34 W., running N. 43° 16′ W. to S. 41° 27′ E. Elevation of collar 331 A. T. East cross-cut 52′ lower; west cross-cut 609′ lower.

Beginning at the north end, the distances are mainly scaled from the Superintendent, T. Dengler's diagram. The descriptions are from a naked eye examination of the specimens he took, and also from my own visit (Aug. 13, 1898) and examination and specimens from 175 feet northwest of the shaft to 460 feet southeast. The thicknesses are obtained from[1] the widths by multiplying by sin 59° 45′=.86.

The thickening should also be reduced by an amount depending on how much the strike differs from being at right angles to the lode. It is east of northeast. If we take the strike of Conglomerate 6 71° E. of N., and of the cross-cut N. 45° W., the angle is 66°, and the drifts run in the north part of the cross-cut indicate some such difference. If we take the strike of the Baltic lode N. 65° E, and that of the cross-cut N. 41° 16′ W., the angle will be 74°. We shall then have to multiply the thicknesses given by .9 or .96 to get a truer thickness.

1. Trap 1846-1810=36+ (31+)
   Stopped at 1846 feet of "West drift" 12:24:1902 on account of large stream of water.
   Amygdaloid 1810-1795=15 (13)
   A. S. 21, rather feldspathic, not amygdaloid.
   A. S. 22, Trap. Ophite 1795-1749=46 (39) (83)
2. Amygdaloid conglomerate 1749-1727=22 (19) (102+)
   A. S. 21, with gray-brown clasolitic material imbedding dark angular fragments.
3. Ophite (should include part of 2?) ?
   A. S. 21, A. S. 20. Trap 1727-1596-131 (112)
4. Ophite (89)
   Amygdaloid 1596-1581=15 (13)
   A. S. 20, poor red and white amygdaloid between decomposed ophite.
   Trap 1581-1502½=78½ (76)
5. Conglomerate 6. 1502½-1479=23½ (20)
   A. S. Belt 19 and No. 6 conglomerate shows rounded basic and felsitic pebbles, with a green chloritic and epidotic matrix and calcareous seam underlain by a crushed amygdaloid. This also appears in the railroad cut and the conglomerate and underlying amygdaloid which has a birdseye texture are similar.
   Base below beginning of section (211)
6. Ophite. (50)
   Amygdaloid 1479-1468=11 (9)
   A. S. 19, crushed amygdaloid, red and white, fine grained, sheared into birdseyes 1-2 mm. across.
   Trap 1468-1420=48 (41)
7. Ophite. (224)
   Amygdaloid 1420-1401.7=18.3 (15½)
   A. S. 18, fresh, clear, maroon and white amygdaloid, not crushed.
   The same horizon seems to appear back of the church and Baltic hotel.
   Trap 1401.7-1157=244.7 (208)

[1]The strike is supposed to be at right angles to the adit which is from S. 44° E. to S. 48° E. in direction.

8. Ophite. (133)
   Amygdaloid 1157-1139=18 (15)
   A. S. 17. Poor amygdaloid here.
   Trap 1139-1000=139 (118)
   A. S. 17. Foot of above, ophite with chlorite and calcite seams.
   Base below base of conglomerate 6 (407) to (366)
9. Ophite. (158)
   Amygdaloid 1000-980=20 (17)
   A. S. 16. A crushed and brecciated, red and white amygdaloid, with some copper so that a drift was run on it southwest some 200 feet.
   Trap 980-814=166 (141)
   Foot of A. S. 16 is an ophite, also hanging of A. S. 15.
10. Ophite. (137)
    Amygdaloid 814-788=26 (22)
    A. S. 15. Coarse gray and white amygdaloid.
    Trap 788-653=135 (115)
    Foot of A. S. 15 is an ophite, also hanging of 11.
11. Amygdaloidal conglomerate 653-643 (9)
    Conglomerate with fine red sediment as cement. Hanging and foot are ophites. Cf. at the Baltic location the amygdaloidal conglomerate on the knob 4 lots south of 2nd street on 10th Ave., and 2 lots S. of Stanton on 15th Ave. This may be near the horizon of Conglomerate 4. Total from base of conglomerate 6, 1479-643=836 (711)
    or multiplying by .9 (640 feet).
12. (68)
    Amygdaloid? 643-633=10 (9)
    Trap 633-563=70 (60)
    S. 14 ophite.
13. (84)
    Amygdaloid 563-542=21 (18)
    S. 13. Massive, fissured, compact, only slightly amygdaloid.
    Trap 542-464=78 (66)
14. (122)
    Amygdaloid 464-454=10 (9)
    S. 12. Red and white (prehnite, calcite, laumontite) amygdaloid.
    There was a drift southwest on this belt for about 400 feet. It was decomposed and full of laumontite seams.
    Trap 454-321=133 (113)
    S. with "Cong. 4" hanging of the same,—an ophite.
15. Conglomerate 321-299=22 (19)
    This seems to correspond to an amygdaloid conglomerate on 2nd street at Baltic, just east of 15th street, which is about 1100 feet from and about 1000 feet below Conglomerate 6.
    Marvine's Conglomerate 4 is not more than 560 feet below Conglomerate 6 and probably is represented by some of the higher belts. The Baltic sandstone and the amygdaloid conglomerate on top of the next ophite seem to correspond to amygdaloids A. S. 17 and A. S. 16. The drift on S. 16 indicates this strongly. The top of A. S. 17 is (274) to (250) feet below Conglomerate 6, while Conglomerate 5 is only (290). I should therefore be inclined to identify the "Baltic sandstone" with Conglomerate 5, which is only an amygdaloid conglomerate.
    The top of Belt 10, A. S. 16, is at about the same distance from Con-

glomerate 6 as Conglomerate 4 (540 feet), which is described by Marvine (II b p. 65 of Vol. I) as perhaps amygdaloid, "strongly resembling a conglomerate or breccia of altered trap pebbles." About 144 feet below it (684 feet) he describes an "amygdaloid ? with brown porous portions surrounded by a yellow sandy material" which is an amygdaloid conglomerate and is perhaps the correlative of 11. Neither Conglomerate 4 or 5 are marked horizons as distinguished from the tops of many of these flows. Then this Belt 15, which Dengler naturally in drifting up from near Conglomerate 3 at first called "Conglomerate 4," may find its match in 147 feet "covered" just above the Mabb ophite, in which case Belt 16 would be the Mabb ophite and the Baltic lode be only a short distance below, say at 143 or 209 in the east cross-cut. This is a quite possible correlation, but would bring the lode as much too near as the correlation adopted does too far from Conglomerate 6, and Belt 16 is not as coarsely mottled as the Mabb ophite.

"Cong. 4" has round felsitic or basic pebbles and epidotic cement.

16. A large ophite. The Mabb ophite?

299-53 W 0-85 E=321 (274)

Base below base of 11 (293)

" " " " Conglomerate 6 (1005)

Belt 11½. Epidote and amygdaloid directly under the conglomerate at 270. I examined these on the first level to 175 feet taking samples every 25 feet to 175 inclusive, Ss. 17884-17878. From 75-125 it is seamed so that the mottling is obscure but at Sp. 17879 is 4 mm. + and 17885 at 0 is 3 mm. +. Also going S. 17886 is 2 mm. and there is no marked belt until 90′ south.

Apparently 0 in this level corresponds to 53 in the level below.

In Dengler's samples there is some confusion. 0 on west cross-cut is a well-defined amygdaloid. No. 6 (sic 0?) belt at foot of shaft is not an amygdaloid but probably a much shattered ophite 2-3 mm. coarse.

Dengler also says that in the second level the amygdaloid from 85-137 feet southeast of the shaft does not appear.

There was also a drift southeast (near No. 3 plug) about 200 northwest of the shaft in the second level. In the sample bag is a genuine maroon amygdaloid, a 1-2 mm. ophite, and a 5 mm. decomposed ophite like that of the level above, where no amygdaloid was noted at this level. According to Dengler there was a seam of sandstone with a black "foot" trap, and a "hanging" mottled with chlorite, while at 175 feet from Plug 2, i. e., 183 feet in the level the trap is gray. Judging by my own notes and samples I should make but one somewhat sheared belt from 299 E. to 85 W., with a thickness not far from 300 feet, except for the mottling which does not appear to be over 5 mm. If there are two belts they are either repeated or a piece is cut out at the shearing zone. It seems quite possible in view of the sudden change from the steep dip at the Baltic to relatively flatter dips and a section extending farther southeast, while at the same time there are numerous veins and fissures in the cross-cut running as steep as 70° to 80° that there should be slide faulting producing repetition here, or possibly producing erosion of part of the section at the Baltic.

17. Amygdaloid conglomerate (99)

Amygdaloid 85-137 and ophite 52 (44)

I made it 90-142 measuring from a little different starting point.

S. 1. Fine grained dark trap, and dark amygdaloid with chalky white blotches of decomposed prehnite, like the Isle Royale Sec. 12 shaft, also maroon, very amygdaloid fragments in a calcitic matrix. Heavy brecciated amygdaloid, like a bed just above the Baltic lode.

Sp. 17889 at 100 is slightly brecciated, and amygdaloidal.

Sp. 17890 at 125 is much more so.

Trap 137-201=64 (55)

About 10′ below the top is a seam with a little copper[1] and at 150 it is still fine grained and porphyritic in a minute way. At 175 (Ss. 17891, 17892) the ophitic mottles are 3-5 mm. At 200 (Sp. 17893) there are small chlorite amygdules, but the mottling is still 2-4 mm., and there does not appear to be a top contact or new flow.

18. Ophite. (37)

Amygdaloid 201-208=7 (6)

"Belt 2" is a coarse red and white amygdaloid, which must be some other I think. "2 hanging at 201′ E. of Shaft 7 feet" has a purplish base and *sparse* fairly large, (20 mm. at times) chlorite or chlorite and calcite amygdules. A little copper was found in this. This is nowhere near as marked as the belt above. Sp. 17894 at 204, however, shows a marked amygdaloid with a fine grained maroon base and greenish amygdules of altered prehnite.

Trap 208-244=36 (31)

Sp. 17895 at 225 shows 2-3 mm. mottles, with calcite veins.

19. Ophite. (80)

Amygdaloid 244-282=38 (32)

(The strike line of the Baltic mine crosses the foot of this amygdaloid, the breadth allowed on the mine plan is rather generous; at 275 it is trap).

S. 3 and Sp. 17896 at 250 feet represent this. A well-marked maroon amygdaloid, *not notably* crushed, greenish amygdules with calcite and with white kaolinic matter (? decomposed prehnite).

Trap 282-339=57 (48½) represented by

Sp. 17897 at 275, a massive faint ophite, with a mottling perhaps 1-2 mm.

Sp. 17878 at 300, a massive trap blotched with a few coarse pink, green or calcite amygdules.

Sp. 17899 at 325, massive,—a 2 mm. ophite.

20. Ophite. (76)

Amygdaloid 339-359=20 (17)

S. 4 fine grained, brown with coarse large amygdules, and much greenish to white altered prehnite.

Trap 359-428=69 (59) represented by

Sp. 17943 at 375 (at 385 is a nearly vertical seam) a massive, fine grained ophite.

Sp. 17944 at 414 is a massive 2-3 mm. ophite.

21. Ophite. (137)

Amygdaloid 428-455=27 (23)

S. 5 shows well-marked amygdaloid, purplish with greenish and white amygdules, also an ophite 3 x 1 mm., this belt being taken too wide.

At 419 is a streak of amygdaloid and at 437 to 454 is a broken amygdaloid.

Sp. 17945 at 444 is fine grained and full of little chlorite blotches.

Trap 455-588=133 (114) represented by 17946

Sp. 17946 at 460 is a 1-2 mm. ophite.

[1]The tendency of copper to occur in the foot of the Baltic lode is marked.

22. (37)
Amygdaloid 588-619=31 (26)
Trap 619-632=13 (11)
S. 6.
23. The Mabb ophite? (205)
Amygdaloid 632-653=23 (19½)
Trap 655-873=218 (185)
S. 7. Very well marked amygdaloid, with many soft greenish (altered prehnite?) kaolinic amygdules.
Base of this below base of Conglomerate 6 (1950) to (1760)
24. Ophite. (61)
Amygdaloid 873-893=20 (17)
Trap 893-945=52 (44)
S. 8. Maroon amygdaloid and ophite.
25. Ophite. (67)
Amygdaloid 945-974=29 (25)
S. 9. Found a small mass of copper above this.
Dip 59°¾±. Sample fine grained epidote, with some quartz epidote copper vein, and also fine grained ophite. This may be the Baltic lode.

Trap 974-1024=50 (43)
26.
Amygdaloid 1024-1051=27 (23)
S. 10. Purplish with minute, flesh colored or coarser amygdules, or with few chloritic amygdules.
27. Conglomerate 3. 1051-1056=5 (4)

Base below base of 7 mm. ophite (155)
" " " " Conglomerate 6 (2105)
28.
Amygdaloid 1056-1066=10 (9)
S. 11 (or is it 2) a maroon amygdaloid.
29. Trap 1066-1080=14 (12)
Direction at end S. 41° 27′ E., and the beds strike more nearly E. & W., say N. 55° E.

§17. BALTIC.

Leaving the Atlantic section we find on the Baltic (File 13.31) a series of amygdaloid conglomerates and ophites which can be pretty well paralleled with those in the long cross-cut, and directly continues the South Range section. We also find very heavy trap a short distance above the Baltic lode and on the whole a fairly complete section (Pl. X). The numbers in parenthesis are corrected perpendicular distances from No. 6.

Conglomerate 6, north side of Stanton Street between 11 and 12. 525 A. L. S.
6.[1] Fine grained ophite (50) (50)

[1]These numbers refer to the belts of the Atlantic cross-cut above.

7. Clasolitic amygdaloid south side of Stanton and in railroad-cut in trenches northwest of church and on 13th Street. 11

Ophite 5 mm. 239 (300)
8. "Baltic sandstone,"—an amygdaloid conglomerate with much red sandy matrix 40

Ophite 2 mm. 90 (430)
9. Amygdaloid conglomerate 20
Ophite 4 mm. Perhaps two flows. First 60 feet exposed on 14th Street 190 (540)
10. Amygdaloid brecciated, third lot south on 13th St 30

Ophite 5-7 mm. 170 (740)
11. Amygdaloid conglomerate; knob on 10th St.; 50 feet north of corner of 2nd and 13th St.; and lot south of Stanton on 15th St. A strong belt. 33 to 50 (765?)

50 (840)
Ophite 3 mm.
12. Amygdaloid brecciated. Close to school house 20
Ophite 100 feet south of 2nd on 13th St., and southwest of school house, green blotched fine grained bed, perhaps three flows

270 (1130)
15. Amygdaloid conglomerate. On 2nd between 15th and 16th Sts.; shows irregular bottom contact and width. 10 to 30.

Ophite 6 to 7 mm. 270 (1420)
Amygdaloid conglomerate 20
16. Mabb ophite 7 mm. In front of Mine office, about 250 feet above Baltic lode; 200 (1620)
70 feet of it with banded lines of flow.
Amygdaloid. Corner of 14th and 3rd Sts., skeins are chloritic and red 20

Trap skeined and banded 54 (1700)
Amygdaloid black and white; elevation near No. 3 shaft 470 A. L. S. 50

Ophite skeined and banded 55 (1805)
Baltic lode? 40

Baltic foot 160 + 90 (1960)

Baltic conglomerate 4 (1964)

It will be noticed that the copper occurs between a heavy impervious bed—the Mabb ophite—and an open pervious water bearing one—the Baltic or No. 3 Conglomerate, like the Medora lode and various occurrences just below the Greenstone, and the lode at the Lake. This section has importance in comparisons as this lode has been much sought of late.